SYSTEMATIC DESIGN OF SIMPLY STRUCTURED COMPENSATOR

By

FUNG CHUN TING

FINAL REPORT

Submitted to the Electrical & Electronics Engineering Programme
in Partial Fulfillment of the Requirements
for the Degree
Bachelor of Engineering (Hons)
(Electrical & Electronics Engineering)

Universiti Teknologi Petronas
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

© Copyright 2005
by
Fung Chun Ting, 2005

CERTIFICATION OF APPROVAL

SYSTEMATIC DESIGN OF SIMPLY STRUCTURED COMPENSATOR

by

Fung Chun Ting

A project dissertation submitted to the
Electrical & Electronics Engineering Programme
Universiti Teknologi PETRONAS
in partial fulfillment of the requirement for the
Bachelor of Engineering (Hons)
(Electrical & Electronics Engineering)

Approved:

Mrs. Zazilah May
Project Supervisor

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK

June 2005

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

Fung

Fung Chun Ting

ABSTRACT

PID controllers have been the most common type of compensators in the past and will continue in the near future. Effort has been taken by researchers to develop simple and systematic way to design these controllers.

This project aims to develop the algorithm for the tuning method that based on Nyquist Stability Criterion and at later stage build a Neural Network Model to predict the tuning parameters for the PID controller.

Recently, it has been revealed the possibility that the fine-tuning method based on Nyquist Stability Criterion has the potential to output a satisfactory closed-loop performance for a given continuous, linear system model. In addition, design of compensator based on Nyquist Stability Criterion is simpler and more robust [3]. On the other hand, Neural Network has become tremendously popular in the control application due to its ability in adaptive learning and approximating function. By implementing Nyquist Stability Criterion's tuning algorithm with Neural Network, this will definitely enhance the process of tuning the PID controller.

In this project, the algorithm of the tuning method based on Nyquist Stability Criterion is developed first. Then, data are generated to be used in training the neural network. The NN is used to predict the tuning parameters of PID controller for second order system. The whole project is implemented in MATLAB program.

The result obtained in this project has actually showed that the tuning rule based on Nyquist Stability Criterion can fine-tune the PID controller and eventually improve the closed-loop system. Meanwhile the NN model built has been able to predict the parameters for PID controller at the accuracy of 5% MSE.

In the final part of this report, conclusions are drawn and some future work for future development is proposed.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to God for giving me hope and will to do the development and simulation work with enthusiasm and joy. Without His help, I will not be able to make it a reality.

There are also people who I would like to express my appreciation that has contributed directly or indirectly to this work. I am grateful to Ms. Zazilah May, my supervisor who really acts as my inspiration of the project. Her guidance, encouragement, helps and supervision has made this work proceeded successfully. Her highly cooperation in giving ideas and time for this project really made me aware that I have to complete my work as "perfect" as I can.

My appreciation would also goes to Prof. Radhakrishnan, Prof. Marzuki Khalid, Assoc. Prof Dr. Mohd Noh Karsiti, Dr. Nordin bin Saad, Miss Noor Hazrin and Mr. Fawnizu for their help in contributing ideas and advise and also to the UTP librarian for helping me finding the journals related to the project.

Finally, it is a pleasure to thank my family for their understanding, and friends for their consideration.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

Enter list of abbreviations here:

1. PID Controller – Proportional Integral and Derivative Controller
2. NN – Neural Network
3. K_p - Proportional Term
4. K_i - Integral Term
5. K_d - Derivative Term
6. I/O – Input Output
7. MSE – Mean Square Error

CHAPTER 1
INTRODUCTION

1.1 Background of Study

PID controller is by far the most commonly control algorithm used. It is reported that 95% of the controller system in the process application utilized PID type [1]. The popularity of the PID controller is due to the simplicity of implementation, robustness, and also wide range of applicability. In addition, it can be easily modified, updated and relatively low cost. In PID controller, there are three adjustable parameters that are the proportional term (K_p), integral term (K_i) and derivative term (K_d). These parameters are necessary to be adjusted to appropriate values otherwise the system performs poorly. For example, the system may become unstable. The procedure of adjusting the controller parameters is called as the tuning procedure.

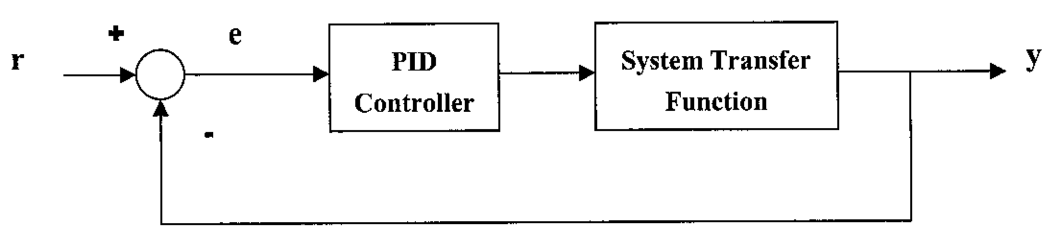


Figure 1 : The closed-loop feedback control system with the PID controller

The transfer function of PID controller is:

$$G_c(s) = K_p + \frac{K_i}{s} + K_d s \qquad \text{--------------------} \qquad (1.1)$$

where K_p is the proportional term, K_i is the integral terms and the K_d is the derivative term that are the three adjustable parameters in the PID Controller.

1.2 Problem Statement

Although the actual structure of a PID controller is simple, systematically tuning a PID controller can be a challenge. According to Dr.M.J. Willis, a random survey conducted in 1998 on the PID controller in the industry has indicated [2]:

1. 30% of installed controllers operate manually.
2. 30% of loops increased variability
3. 25% of loops use default settings.
4. 30% of loops have equipment problems

The problem arise because the existing tuning techniques is suitable only for a small subset of systems either due to the shortages of the tuning rules itself, or because lack of understanding of the user on the tuning procedures. For example, the Ziegler – Nichols tuning rule as well has some limitations. The most significant shortages are; the parameters are hard to be determined, too low damping, time consuming, and the determination of only two parameters are not enough to give the optimal performance of the PID.

1.3 Objectives and Scope of Study

1.3.1 Objectives

Several objectives have been drawn to be achieved at the end of the project:

1. To develop the algorithm of the fine-tuning method that based on the Nyquist Stability Criterion for the PID controller.
2. To demonstrate that the fine-tuning method based on Nyquist Stability Criterion can be used to optimize the performance of a system.
3. To build a Neural Network Model to fine tune the PID controller for a closed-loop second order system.
4. To create a GUI control panel for the program developed.

1.3.2 Scope of the Study

The scope of the project is to study the characteristics of the method in fine-tuning the PID controller that based on the Nyquist Stability Criterion. The algorithm of the method will be developed in m-file of Matlab program.

The program that has been developed will be used to generate data. The data is used to train the Neural Network. In this project, the data are generated for second order system. However, the data has to be processed first. This includes data segmentation, performing ANOVA and Normal Distribution Test and lastly normalization of the data. At the end, Mean Square Error of the output prediction for the Neural Network model is calculated.

CHAPTER 2
LITERATURE REVIEW

2.1 Proportional Integral and Derivative (PID) Controller

The three adjustable parameters of PID controller namely K_p, K_i and K_d has the effect on the dynamics of the output response. A proportional control (K_p) can reduce the rise time but will never eliminate the steady-state error. Meanwhile, an integral control (K_i) can eliminate the steady-state error, but the trade off is that the transient response will be worse. The derivative control (K_d) will have the effect of increasing the stability of the system, reducing the overshoot, and improving the transient response. In general, there is always a trade off that incurred when trying to improve an element in the response through the adjustment of the parameters. Effects of each of the controller parameters K_p, K_i, and K_d on a closed-loop system are summarized in the table shown:

Table 1 : The relationship among the parameters in the PID controllers

Controller	**Rise Time**	**Overshoot**	**Settling Time**	**S-S Error**
K_p	Decrease	Increase	Small Change	Decrease
K_i	Decrease	Increase	Increase	Eliminate
K_d	Small Change	Decrease	Decrease	Small Change

2.2 Nyquist Stability Criterion

The Nyquist Stability Criterion is used to determine the stability of a system. It relates the stability of a closed-loop system to the open-loop frequency response and open-loop pole location.

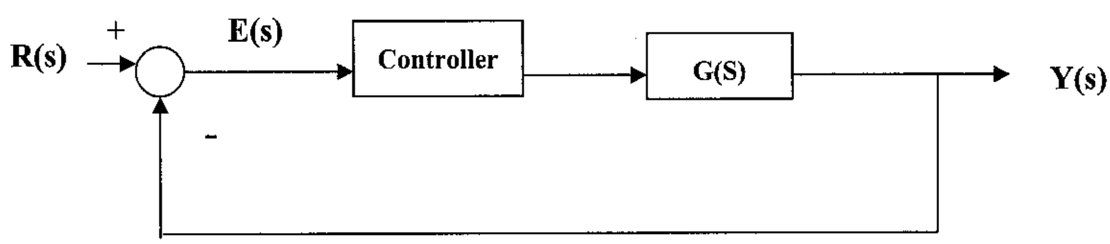


Figure 2 : The closed-loop feedback system

From the figure above, the transfer function of the closed-loop system is:

$$\frac{Y(s)}{R(s)} = H(s) = \frac{KG(s)}{1+KG(s)} \qquad \text{-----------------------} \quad (2.1)$$

and the closed-loop roots are the solutions of,

$$1 + KG(s) = 0 \qquad \text{-----------------------} \quad (2.2)$$

According to the argument principle, a contour will only encircle the origin if the contour contains a singularity (pole or zero) of the function. If the evaluation contour of s enclosing the entire Right-Half-Plane (RHP) contains a zero or pole of *1+KG(s)*, then the evaluated contour of *1+KG(s)* will encircle the origin. Notice, *1+KG(s)* is just simply *KG(s)* shifted to the right by 1 unit. Instead of plotting the closed-loop of *1+KG(s)*, we can actually plot KG(s) with *–1+j0* as the new critical point replacing the origin point. The presentation of the contour evaluation of *KG(s)* is what we called as the Nyquist plot.

From the Nyquist plot of the open-loop system, the stability of a system can be analyzed based on the following Nyquist Stability Criterion formula:

$$Z = N + P \qquad \text{-------------------} \quad (2.3)$$

Notation:

Z = number of zeroes of $1+KG(s)$ in the right half s plane or number of unstable closed loop poles.

N = number of clockwise encirclements of the $-1+j0$ point from the Nyquist plot

P = number of poles of $KG(s)$ in the right half s- plane

For stability, Z must be equal to zero; that is no closed-loop pole in the RHP. In short, the contour evaluation of an open-loop system can be used to determine the stability of the closed-loop system.

2.3 Ziegler Nichols Tuning Method

2.3.1 Ziegler Nichols's first method

The first method is used with the system that with decay ratio of approximately 0.25. The method only needs to measure the system responses and are generally applicable to type 0 systems of any order that are commonly found in process control applications.

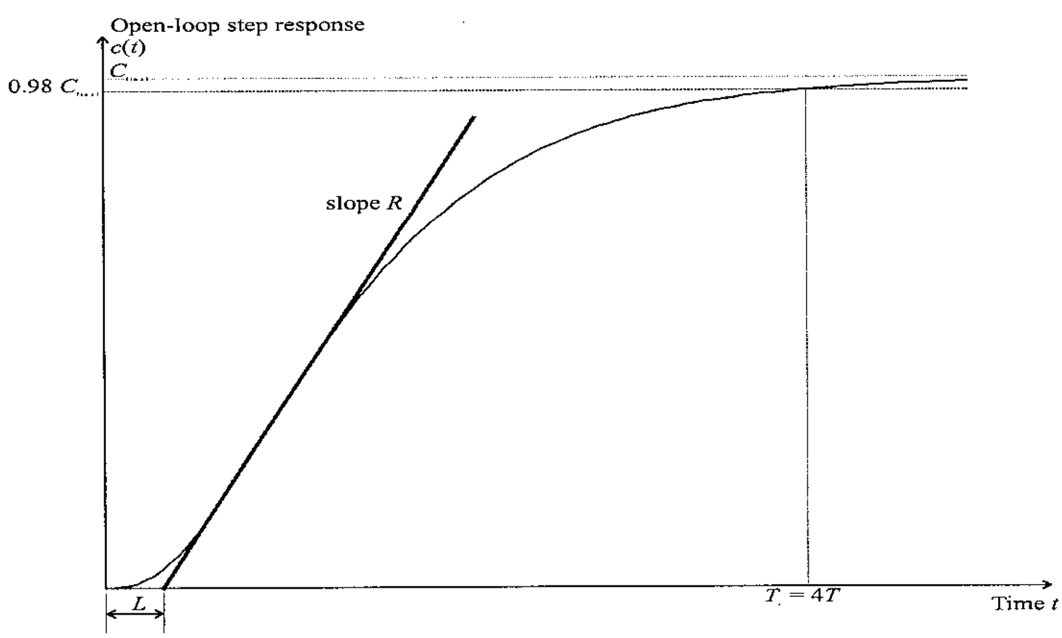


Figure 3 : Open-loop step response for a typical process control system

From this response it is necessary to determine only two parameters.

i. The slope R of the tangent to the steepest part of the rising edge.

ii. The "apparent dead-time" L (which is the intersection of the tangent with the time axis).

Given that $a = RL$, the PID parameters are then tuned according to Table 2.

Table 2: Tuning parameters for Zeigler-Nichols time response method

Type	K_p	K_i	K_d
P	$1/a$		
PI	0.9/a	$3L$	
PID	$1.2/a$	$2L$	$0.5L$

2.3.2 Ziegler Nichols's Second Method

This tuning algorithm works for type 0 systems that have order greater than 2. The tuning method relies on being able to find the gain at which the Nyquist response crosses the critical point or equivalently when the root locus crosses the imaginary axis. The gain is obtained experimentally with the following procedure. First, set the controller to P mode only. Next, set the gain of the controller (K_p) to a small value. Make a small set point (or load) change and observe the response of the controlled variable. If K_p is low the response should be sluggish. Increase K_p by a factor of two and make another small change in the set point or the load. Keep increasing K_p (by a factor of two) until the response becomes oscillatory. Finally, adjust K_p until a response is obtained that produces continuous oscillations. This is known as the ultimate gain (K_u). Note the period of the oscillations (P_u). The K_p, K_i and K_d are then obtained from the following table:

Table 3: The parameters adjustment for Ziegler – Nichols second method

Type	K_p	K_i	K_d
P	$K_u / 2$		
PI	$K_u / 2.2$	$P_u / 1.2$	
PID	$K_u / 1.7$	$P_u / 2$	$P_u / 8$

Notation :

K_u = Ultimate gain

P_u = Period of oscillation

* In Ziegler Nichols, the proportional term is known, as K_c. To avoid confusion, we replaced K_c with K_p for standardization purpose.

2.4 Performance Indexes

In order to measure the quality of a response, performance index is introduced. Performance index is used to characterize the error that occurred in a step response. Normally, a small value indicates that the response is well tuned and provides optimum performance. A performance index should have three basic properties: reliability, ease of application and selectivity [3]. There are various types of performance index. Each of them will be briefly discussed:

2.4.1 Integral of Errors (IE)

$$IE = \int_0^\infty e(t)dt \qquad \text{--------------------} \quad (2.4)$$

This performance index is best suited for system, which does not overshoot. However, it gives inaccurate performance index for a system that has a characteristic underdamped because the summation of the positive and negative error resulting in zero contribution to the index

2.4.2 *Integral of Squared Error (ISE)*

$$ISE = \int_0^\infty e^2(t)dt \qquad \text{-----------------------} \qquad (2.5)$$

The ISE performance index avoids the problem of the IE for not being able to account the performance of underdamped system. In this method, the squared of the error either it is positive or negative will contribute towards positive to the overall of the value of the index. However, this will impose another drawbacks, it will not able to discriminate between the excessively overdamped and underdamped system.

2.4.3 *Integral of Absolute Error (IAE)*

$$IAE = \int_0^\infty | e(t) | dt \qquad \text{-----------------------} \qquad (2.6)$$

IAE is the typical choice as the performance index. The performance index is selectively good enough to evaluate the quality of the response

2.4.4 *Integral of time multiplied by Absolute Error (ITAE)*

$$ITAE = \int_0^\infty t | e(t) | dt \qquad \text{-----------------------} \qquad (2.7)$$

Although IAE is good enough to accommodate most of the control system, ITAE can further improve the evaluation of the quality of a response. The performance index, ITAE introduced the time weighting which will reduce the contribution of the relatively large initial error to the value of the performance integral. Thus, it will give a more accurate evaluation of a system response.

From the description, ITAE is chosen for evaluation on the performance of the step response in this project.

2.5 Neural Network

The type of neural network most commonly used is the feedforward multilayer neural network, where no information is fed back during operation. There is, however, feedback information available during training. Supervised learning methods, where the neural network is trained to learn input/output patterns presented to it, are typically used. The individual neuron activation functions most often are sigmoid functions, but they can also be signum or Gaussian functions.

2.5.1 Backpropagation

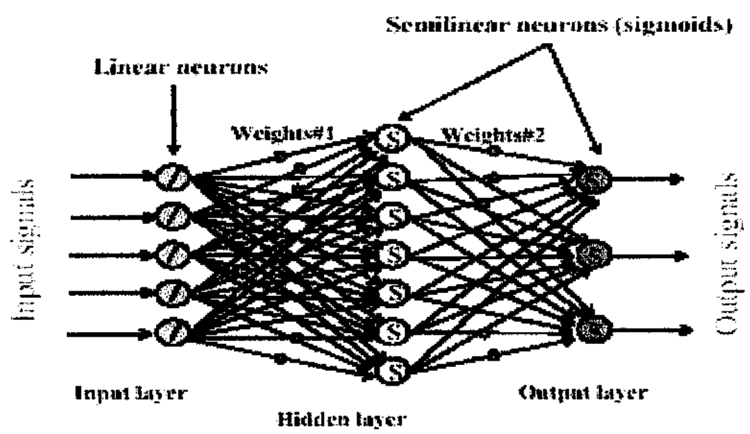


Figure 4 : The structure of feedforward multilayer NN [4]

The Backpropagation (BP) algorithm is perhaps the most popular and widely used learning algorithm in the feedforward multilayer neural network. It is a supervised learning algorithm that needs target patterns or signals to train up the network. Once the data is inserted to the BP network, error between the output and the target is calculated at every iteration and is backpropagated through the layers of the NN to adapt the weights. The weights are adapted such that the error is minimized. Once the error has reached a justified minimum value, the training is stopped, and the neural network is reconfigured in the recall mode to solve the task. There are formulas used to calculate the errors and adaptation of the weights. Those formulas are discussed in the following example.

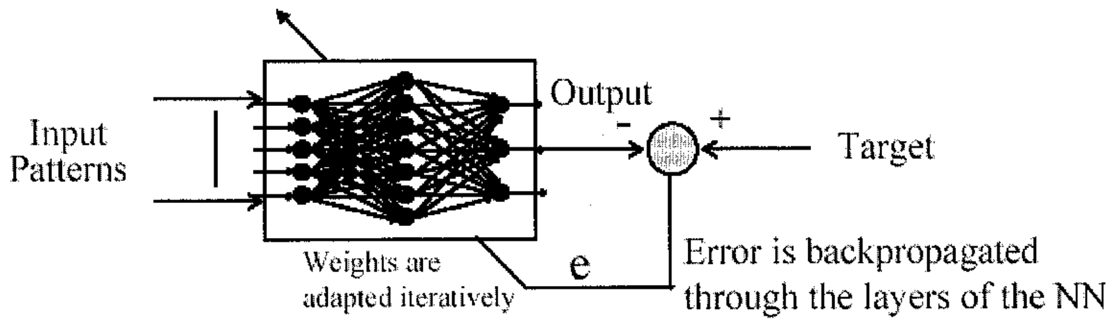


Figure 5 : Training of the NN with Backpropagation learning algorithm [4]

An example is illustrated for the purpose of explanation

Example:

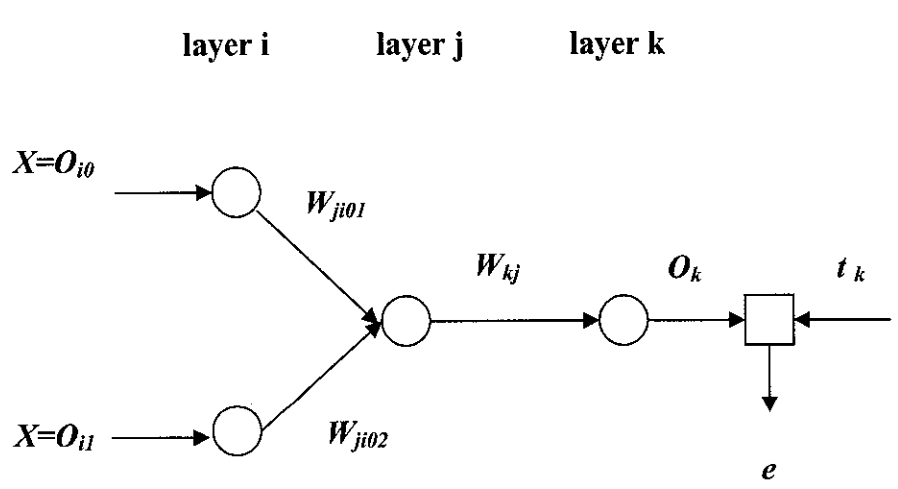


Figure 6 : The two-input and one-output Backpropagation structure

Assume there is only one hidden layer, j apart from the two-input layer, *i* and one-output layer, *k*. All the layers are using sigmoid function except the input layer, using the linear transfer function. Also the bias (θ), learning rate (η) and momentum (α) has been set to a certain value initially.

The training begins with pattern #1,

The input, net_j to the hidden layer j, from the 2-input of layer i is calculated as follow:

$$net_j = \sum W_{ji} O_i + \theta_j \qquad \text{-------------------------- (2.8)}$$

The input will be passed through the neurons in the layer. Since, the hidden layer j, is using sigmoid, the output of layer j is:

$$O_j = f(net_j) = \frac{1}{1+e^{-netj}} \qquad \text{-------------------------- (2.9)}$$

The output from the layer j will be weighted again as in as in equation (2.8) before it is feed to the input of layer k, net_k.

$$net_k = \sum W_{kj} O_j + \theta_k \qquad \text{------------------------ (2.10)}$$

The output of layer k, which also using a sigmoid function, can be calculated as in equation (2.9):

$$O_k = f(net_k) = \frac{1}{1+e^{-netk}} \qquad \text{------------------------ (2.11)}$$

Comparing the output value of layer k with the target, the difference of the value (error) is calculated:

$$Error,\ E = (t_k - O_k) \qquad \text{------------------------ (2.12)}$$

The calculated errors would backpropagated following the error signal equation, δ . The error signal, δ between output (k) and hidden (j) layer is obtained with the formula:

$$\delta_k = O_k(1 - O_k)(t_k - O_k) \qquad \text{----------------------} \quad (2.13)$$

and between hidden *(j)* and input *(i)* layer, the δ is:

$$\delta_j = O_j(1 - O_j)\sum \delta_k W_{kj} \qquad \text{----------------------} \quad (2.14)$$

The error signal is backpropagated through the layers. The weight between the hidden layer j and output layer k is then adjusted by the amount of:

$$\Delta W_{kj}(t+1) = \eta \delta_k O_j + \alpha \Delta W_{kj}(t) \qquad \text{---------------------} \quad (2.15)$$

The adjusted weight is added to the previous weight to become the weight of the next iteration.

$$W_{kj}(t+1) = W_{kj}(t) + \Delta W_{kj}(t+1) \qquad \text{--------------------} \quad (2.16)$$

The same adjustment of the weight between the hidden layer j and input layer i with the amount as in equation (2.15):

$$\Delta W_{ji}(t+1) = \eta \delta_j O_i + \alpha \Delta W_{ji}(t) \qquad \text{-------------------} \quad (2.17)$$

the new weight of the layer at the next iteration is as follow:

$$W_{ji}(t+1) = W_{ji}(t) + \Delta W_{ji}(t+1) \qquad \text{-------------------} \quad (2.18)$$

After done with the weight adaptation, the same calculation is repeated for the next pattern, pattern#2 and other patterns as well. Once all the patterns are finished, the same procedure is repeated for the second time starting again with pattern #1. This process will continue until the error is smaller than the justified value.

Notation :

net_j = input to the layer j

Oj = output of layer j

e = error between the output and the target

δ = error signal, directly related to the error

W_{ji} = weight between layer j and layer i

η = learning rate

θ = bias value

α = momentum, used for better convergence

Output for sigmoid layer j = $\mathrm{O}_j = f(net_j) = \dfrac{1}{1+e^{-netj}}$

2.6 Statistical Analysis

2.6.1 Data Processing

The purpose of data processing is to process the data so that it can be used successfully for training the NN. The approach for data processing includes data segmentation, performing ANOVA test, testing for normal distribution, and normalization [5].

The study is conducted using random number in specifying the input parameters so that the study is without bias. The set of data is then divided into three sets of data namely training, validation and testing set according to the ratio of 43%: 43%: 14% [5]. In order to verify that the segmented data are from the same population of the original set of data, Analysis of Variance (ANOVA) test is conducted.

Information about the normal distribution of data is important in analyzing the distribution of the data [6]. The following statistics data give information on the normal distribution of the data:

i. Test for symmetry is based on the skewness of the data.
ii. Normality can be tested for symmetric data by comparing the standard deviation with the pseudo standard deviation.
iii. Relative Peakness or Flatness of the data is tested by the Kurtosis.

If the data were normally distributed, the training of the NN would be simpler [7]

The last step in data processing is to normalize the data to the range of [1,0]. The normalization formula is given as:

$$x_n = \frac{x - x_{\min}}{x_{\max} - x_{\min}} \quad \text{------------------------} \quad (2.19)$$

Notation :

x_n is the normalized value

x_{max} is the maximum value

x_{min} is the minimum value

CHAPTER 3
METHODOLOGY

This project has 2 stages of implementation. The first one is the development of the algorithm for Optimal Tuning Based on Nyquist Stability Criterion. The second one is the Neural Network Training, which is a continuation from the first stage as the training data is obtained from the developed algorithm at the first stage. The detailed description of both stages is discussed in the following part.

3.1 Optimal Tuning Based on Nyquist Stability Criterion

3.1.1 Obtaining Stable Region

First of all, a test compensator that comprises of 30 test points is set-up. The test compensator will be used as the base to obtain the stable region. For positive values of x, the axes of y is set up as $y = 1-x$. Meanwhile, for negative values of x, the axes of y is as $y = x+1$. In this project, *y-axis* value represents K_i, *x-axis* value represents K_p and the value of K_d is represented by *z-axis* value. The value of K_d is fixed for each layer of the test compensator.

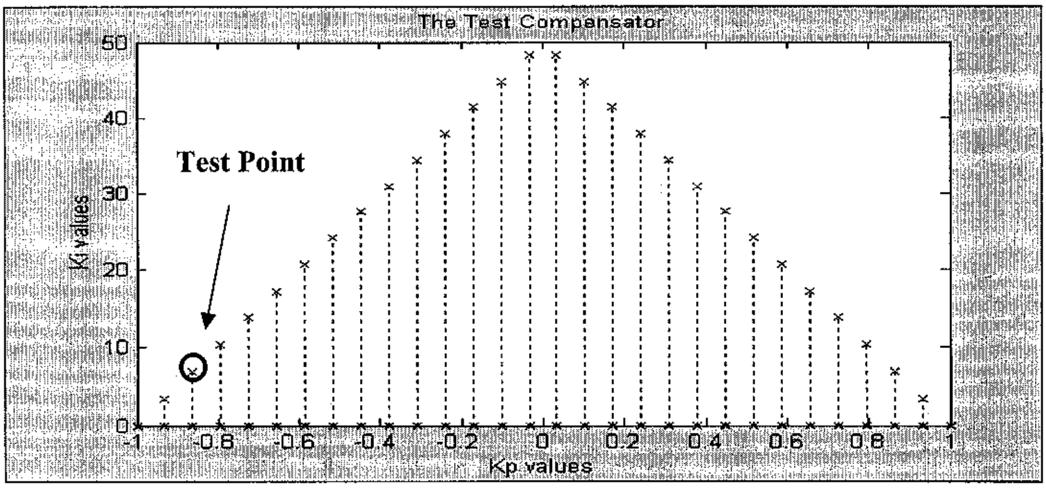


Figure 7 : Test Compensator

From the test compensator, the following procedure is preceded to obtain the stable region:

i. A test point is chosen from the test compensator and substituted into the transfer function of PID Controller as in equation (1.1). In default, the left hand most test point is selected first. Test point is the point selected from the test compensator that represents a particular value of K_i , K_p , *and* K_d as shown in figure 7

ii. The stability of the closed-loop transfer function is analyzed with Nyquist Stability Criterion and the gain margin of the system is obtained. The test point is multiplied with the gain margin to give the end point.

$$end\,point = G_m \; x \; (K_i , K_p , K_d) \qquad \text{------------------} \qquad (3.1)$$

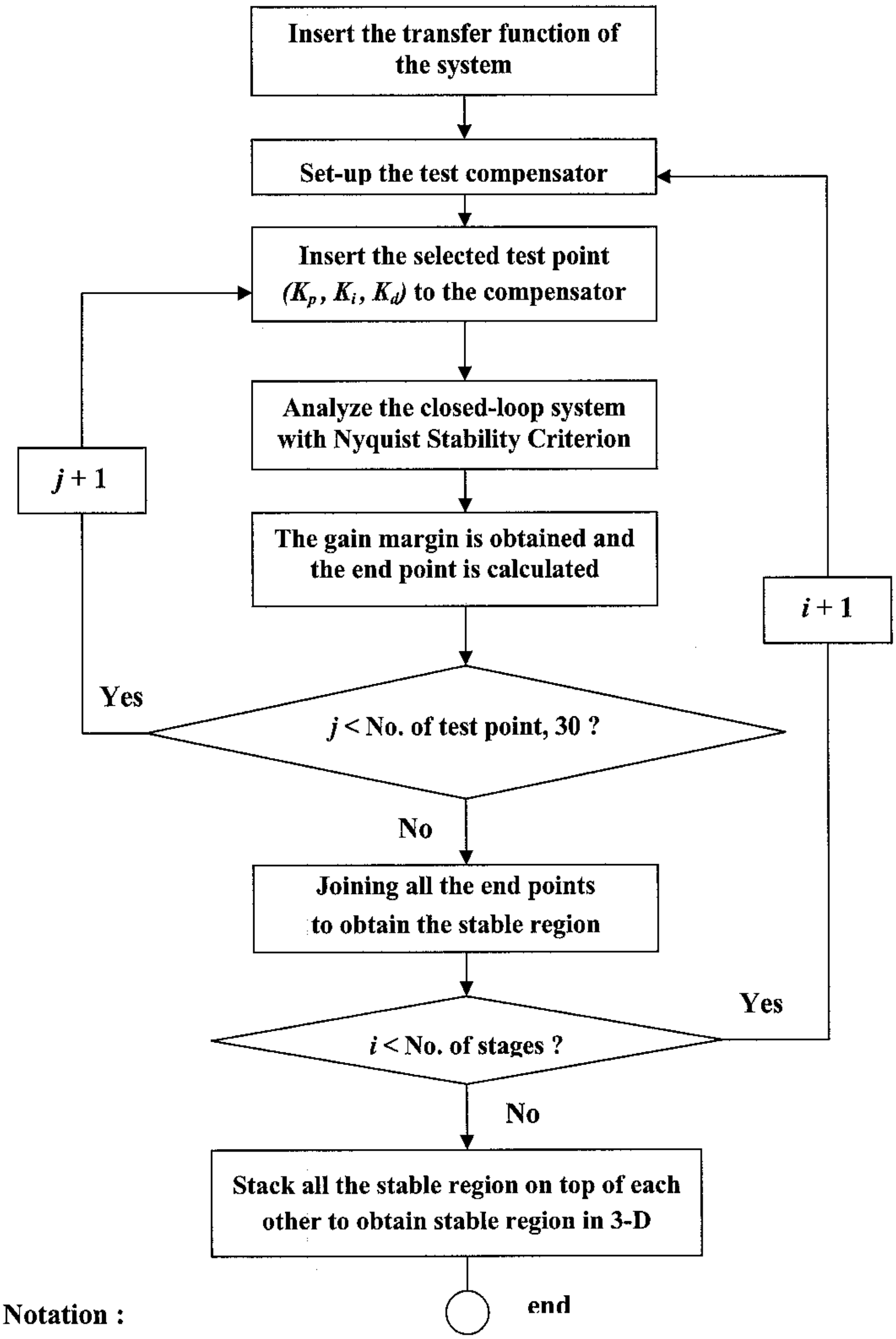
In definition, gain margin is the maximum gain that can be applied to the system before it becomes unstable. Any coordinate between the origin point and the end point can be used to tune the PID controller and it will output a stable system.

iii. This process is repeated for other test points for that particular layer of fixed value of K_d. At the end of the process, all the end points will be joined to each other to form a bounded region. The bounded region is the stable area for a system for that particular value of K_d. Any point chosen from the stable area for tuning the PID controller will output a stable system.

iv. Then, the value of K_d is incremented by 1 and the process in obtaining the stable region for the new value of K_d is repeated.

v. At the end, all the stable regions of different values of K_d are stacked on top of each other to form the 3-D stable region.

Flow chart of the methodology in obtaining the stabilization region



Notation :

i : i represents current number of stages. The initial value of i is 1 when K_d is −7 and the end value of K_d is 5 when i is 13. Each incremental value of i corresponds to the same incremental in the value of K_d.

j : j represents current number of test compensator. The value for j is ranging from 1 to 30.

3.1.2 Searching for BestStarting Point

Before start to search for optimum point, the best starting point has to be determined first. The procedure in obtaining the BestStarting Point is:

i. The position of the open-loop system forward path poles for the original system is determined.

ii. Then, the compensator zero, $S_Z = - K_i / K_P$ (K_d has been initialized to 1 in default) of the PID controller is roughly determined. For convenience, K_p is also fixed to 1

$$K_p = 1$$

which gives the location of the compensator zero depends only the value of integral mode, K_i:

$$Sz = -K_i$$

By substituting the values of K_d and K_i with 1 into equation (1.1), the transfer function of the compensator with the value of $Sz = -K_i$ that yet to be determined as:

$$Compensator = \frac{s^2 + s + K_i}{s} \qquad \text{-------------------} \quad (3.2)$$

iii. The compensator zero, S_Z is placed alternately between the forward path poles. The value of compensator zero value is set to be +/- 0.5 from the system forward path pole position.

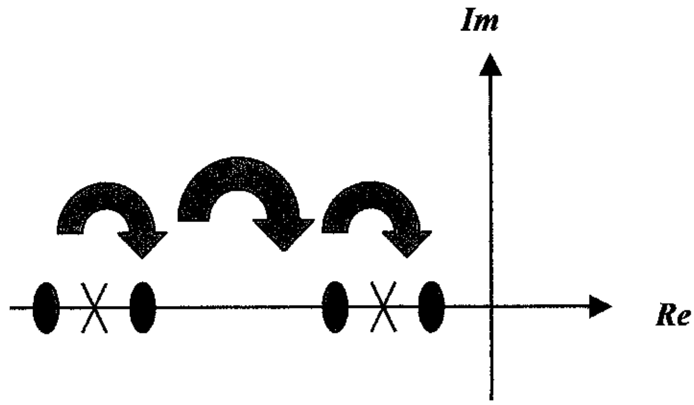


Figure 8 : S_z (zeros) are places alternately between the poles (crosses)

iv. The values of ITAE and the percentage overshoot of the closed-loop system are calculated. The compensator zero, S_Z that resulted in the smallest value of performance index, ITAE of the closed-loop system and also meets the requirement of the percentage of overshoot and undershoot (the maximum allowable percentage overshoot and undershoot is 10%) will be the best starting point.

3.1.3 Searching for Optimum point

From the BestStarting Point module, the optimum search is preceded as follow:

i. The value of K_i (or K_p , K_d in the subsequent stages) is incremented by 1 unit value*. The other two values of tuning parameters remain the same as in the best starting point (or previous stage).

ii. These tuning parameters are substituted into the compensator equation (1.1). The performance index, ITAE value is calculated for the closed-loop system. There are several scenarios that might occur:

__Case I__

If the value of ITAE is lower than the previous one, the search will continue at that direction. At the same times, the compensator parameters (K_i, K_p, K_d) will be placed in a separate array if the closed-loop system meets the overshoot and undershoot requirement (the maximum allowable range is below 20%).

__Case II__

If the first value of ITAE never improves from the current one, it will turn to opposite/negative direction for the current search. The procedure of (i) is repeated but this times the value of the tuning parameters is decreased by 1 unit value instead.

__Case III__

If the first value of ITAE of both directions never improves from the current one, the search at that current direction will be terminated. The search for optimum point will be redirected to the next axis for optimum search. Procedures (iii & iv) are skipped and proceed directly to procedure (i)

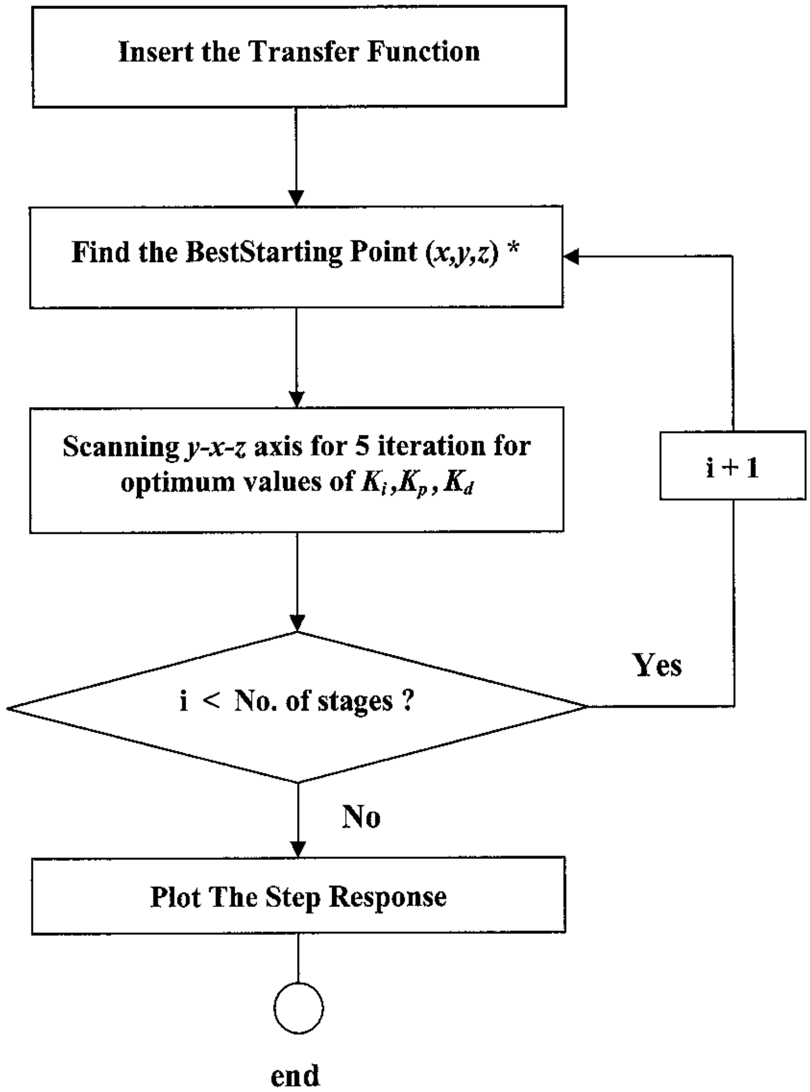
iii. The search at the respective direction will continue as long as the next value of ITAE improved from the previous value of ITAE until it reaches the maximum number of five iterations. The number of iteration might be shorter if the closed-loop system never improved the ITAE value in the middle of the search.

iv. The array that stored the value of the compensator parameters (K_i, K_p, K_d) will be retrieved. The compensators parameters that resulted in the smallest ITAE value of the open-loop system in the array will be selected as the optimum point at the *y*-axis search. The process will continue from the optimum point to start search at the next direction x- axis and lastly is the z-axis.

After finishing one loop of y-x-z axis search, the procedure is repeated all over again. This process of searching y-x-z axis for optimum value is repeated for five times.

* 1 unit value is different for different axes. 1 unit value in y-axis is 1.0, x-axis is 2.0 and z-axis is 0.5. Usually, x-axis value, which is proportional gain, has higher values than the integral mode, y-axis. On the other hand, integral mode, y-axis has higher value than the derivative value z-axis.

Flow chart of the methodology in searching the optimum point



Notation :

i : current number of iteration. Initial value is 1 and the end value is 5. Each incremental in the value in *i* correspond to the same incremental in K_d.

* The values of *(x,y,z)* is actually (K_p, K_i, K_d).

3.1.4 Modification to the algorithm of the tuning method

The algorithm in searching the optimum point has been modified in order to give a better performance of the closed-loop system. The modification is done on case basic. In this case, modifications are done to cater for second order system. This is because the data generated from this program will be used to train the NN to predict tuning parameters for second order system. Here are the changes to the algorithm of the search.

y-axis search

Since this is the first tuning parameter to be tuned, it is expected there is a large improvement in the ITAE from the previous one at the early stage. When comparing the current ITAE values with the previous ITAE, the previous one is reduced by 15. In most of the case, the integral mode will able to increase the values at the early stage. However, as stages goes by, there will be hardly any significant improvement that is larger than 15 from the previous ITAE. This will avoid the value of integral mode from becoming too high. A too high value of integral mode will introduce overshoot to the system and also makes the system response oscillate unless the improvement in ITAE is significant enough.

x-axis search

In the *y*-axis search, the previous value of ITAE is added 20 to push for incremental in the value for the proportional mode at the early stage. From third iterations onward the previous ITAE is reduced by 0.3 instead when comparing with the current ITAE. Initially, the ITAE value is added because we need the proportional gain to boost for a faster dynamics. However a too high value of K_p is not desirable also, as this will introduce oscillation unless the improvement is significant.

z-axis search

The value of previous ITAE is added with 30 when comparing with the current ITAE and from third iteration onwards, the previous ITAE is reduced by 0.05. The reason to increase the value of previous ITAE is to push for incremental value of K_d in the early iteration to avoid saturation in the search. Usually, the changes in the value of ITAE in the z-axis are very small from one iteration to another. This is because the value of K_d is the last one to be tuned that it has a very tight control that explains not much improvement can be anticipated. Meanwhile, the reason to reduce the value of previous ITAE value from third iteration onwards is that too high value of K_d can introduce undesired high frequency noise.

3.2 Neural Network Architecture

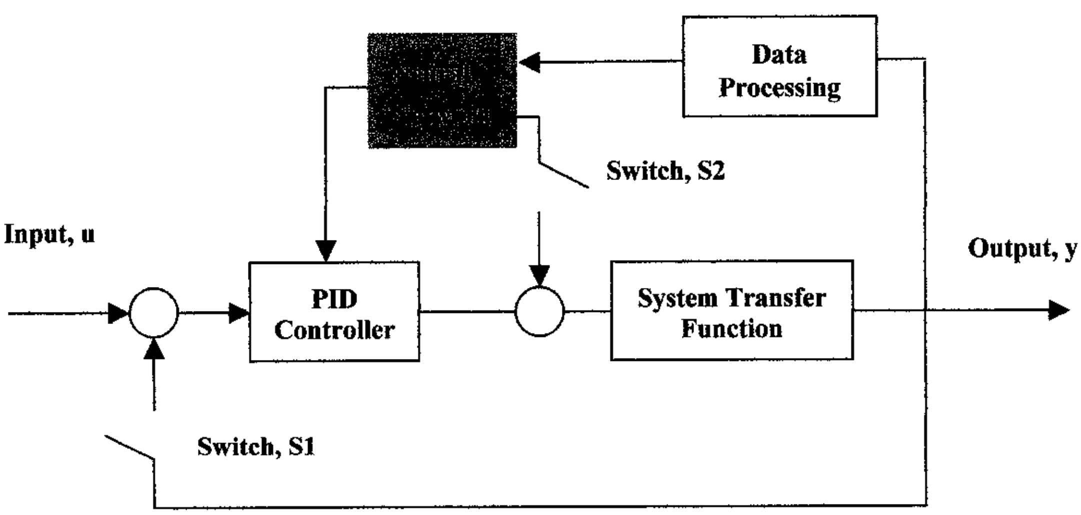


Figure 9 : The closed-loop feedback control system tuned with the NN.

The figure above shows the structure of Neural Network in tuning the PID controller. There are two switches used to connect and break the closed-loop transfer function. In the normal operation, the switch S1 is closed and S2 is opened and the system operates as a closed-loop feedback system. When comes to fine tune the PID controller, the procedure is:

i. Switch, S1 will be opened to break the closed-loop feedback system Switch.

ii. S2 will be closed to enable the loop that comprises the NN and also the system transfer function and at the same time, the PID Controller will be reset to zero.

iii. A square pulse input signal will be injected to the system through switch, S2.

iv. The response of the system will be sampled and the frequency response of it is obtained.

v. The NN will identify the frequency response with the most identical pattern of data and tune the PID controller accordingly.

vi. Then, switch, S2 will be opened and switch, S1 will be closed to return to normal operation.

The process of tuning the parameters of PID controller with Neural Network has been more robust. This is because NN predicts the output directly from the frequency response of the square pulse testing to the system. The NN doesn't need the transfer function of the system in order to predict the tuning parameters. In addition, the prediction of NN takes into account the disturbances that might interfere the system as the disturbances has added up to the frequency response of the output response of the system.

3.2.1 Identification I/O parameters of NN

The input variables of NN relating to this study are the frequency response of the system to the square pulse input. The frequency response from the square pulse is calculated using Fast Frequency Transform (FFT), an algorithm used to calculate the discrete Fourier Transform (DFT). Meanwhile, the outputs for the neural network are the tuning parameters namely (K_i, K_p , K_d) of the PID controller. In the industry, pulse testing is highly desired as it yields reasonably accurate frequency-response curves and requires only a fraction of the time [8]. Theoretically, the best possible would be an impulse. However, it is difficult to have a perfect impulse in real life. Indeed a square pulse is as the test pulse. The magnitude of the square pulse is 20 for duration of 2 seconds that will give significant output response.

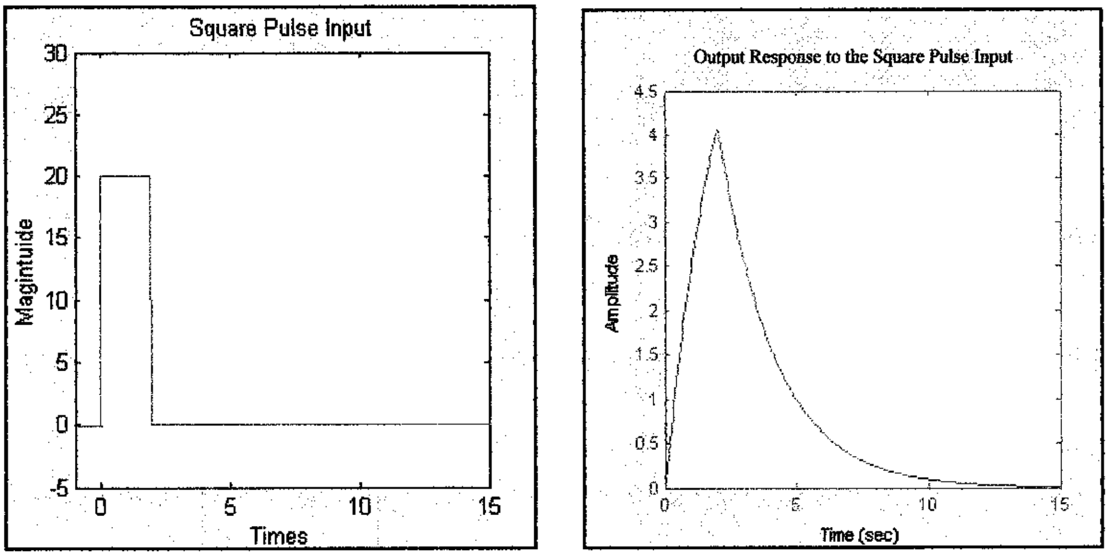


Figure 10 : Square pulse input (left) and the output response (right) from system

3.2.2 Data Generation

772 sets of data are generated to train the neural network in this project. This set of data is segmented into three categories namely: training, validation and testing data. The data generated are actually the variables of *a, b* and *c.* The variables will be used to construct the second order system as showed below. It has the range of value from 1 to 100.

$$G(s) = \frac{a}{s^2 + bs + c} \quad \text{--------------------------} \quad (3.1)$$

For each of the transfer function, a square pulse is injected to the system and the output response of it is sampled at 20Hz.

The sampled output will then be transformed into frequency response using 64-points of FFT. 64-points of FFT has been tested to be adequately representing a particular system.

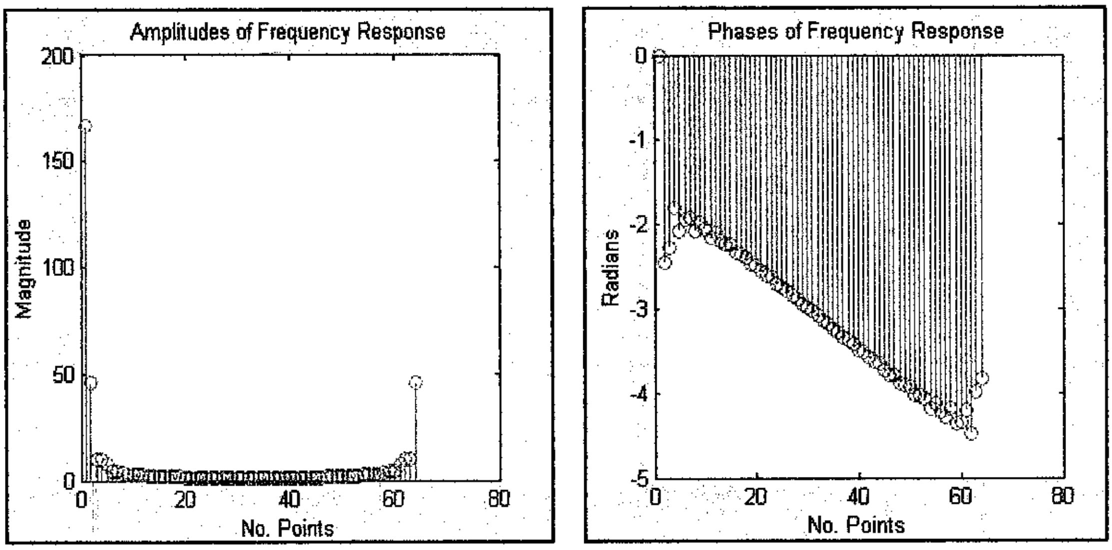


Figure 11 : The amplitudes (left) and the phases of the frequency response

Due to the redundancy of the second half of the system, only the first half of the data points is used. This means only 33 points of the amplitude of the frequency response and also another 33 points for the phases of the frequency are used to be the input of the NN. These totals up of 66 inputs are used for the input of the NN and another 3 tuning parameters for the output of NN. However, out of the 66 inputs, there are two 2 inputs of the data are constant. This 2 constant inputs don't provide useful information of the system, thus it has been discarded that reduces the number of input to 64.

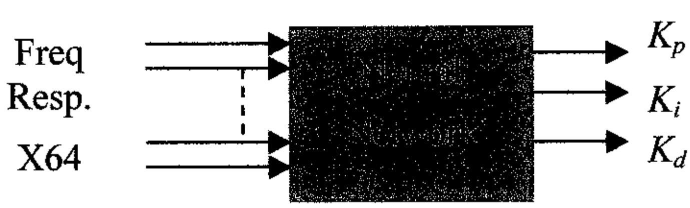


Figure 12 : Block of NN with I/O

In order to avoid complexities, the NN block has been modified by breaking down the structure into three independent networks that each of the neural networks predicts one of the three tuning constants.

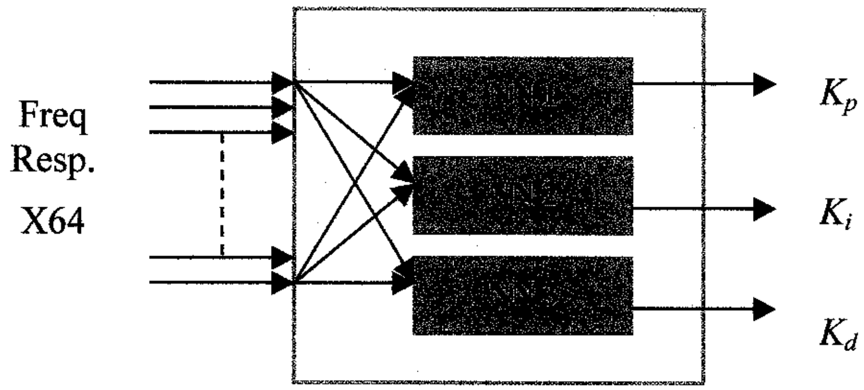


Figure 13 : The Breakdown of Block of NN with I/O

3.2.3 Data Processing

Processing of data is needed so that the data can be used to train the network. The steps involved are:

i. Data Segmentation
ii. Normalization
iii. Normal Distribution Testing

Data Segmentation

The set of data as mentioned are divided into three sets of training, validation and testing data. The ratio between each set is 43% for training data, 43% for the validation data and 14% for the testing data. The process of segmentation is conducted randomly with Microsoft Excel 'Sampling'. The reason of performing segmentation in random is to avoid the study with bias, which will affect the accuracy of the prediction of output of the Neural Network. The size of sampling must be larger than the desired number because the random number will be replaced after selection. No repetition of the random number is allowed.

ANOVA test is performed after the segmentation to verify that the original data and another three segmented data of training, validation and testing sets are from the same population. The test can be performed using the Microsoft Excel's 'ANOVA : Single Factor' which will generate the means and variance of the data. The values for both of this statistical data must be closed enough to each other to verify that the segmented data are from the same population.

Normalization

The purpose of performing normalization is to make the data more manageable and consistent as the study had numerous variables that different in units and ranges. For this purpose, Microsoft's Excel Spreadsheet are used to tabulate and performing normalization calculation.

Testing for Normalization Distribution

The important information in the normal distribution is the skewness, standard deviation and Kurtosis. The information can be generated with Microsoft Excel's 'Descriptive Statistics'. This information can be interpreted as:

i. Test for symmetry – Skewness of the data.

   a. Skew = 0, symmetric,
   b. Skew < 0 assymmetric tail extending to positive values,
   c. Skew > 0 assymmetric tail extending to negative values.

ii. Test for normality for symmetric data – Compare Standard Deviation with Pseudo Standard Ddeviation.

   a. SD = PSD, Normal,
   b. SD > PSD, Heavy Tailed,
   c. SD < PSD, Light Tailed.

iii. Test for flatness of the data – Kurtosis.
   a. Kurt = 0, Normal,
   b. Kurt > 0, Peak Distribution,
   c. Kurt <0 Flat Distribution.

A normal distributed set of data is easier for convergence in training the neural network.

3.2.4 Neural Network Construction and Training

The GUI of Neural Network / Data Manager is used so that the handling of data while training the NN model is easier. The data for the training, validation and testing set of the inputs and outputs are imported to the GUI of Network / Data Manager of Matlab as shown.

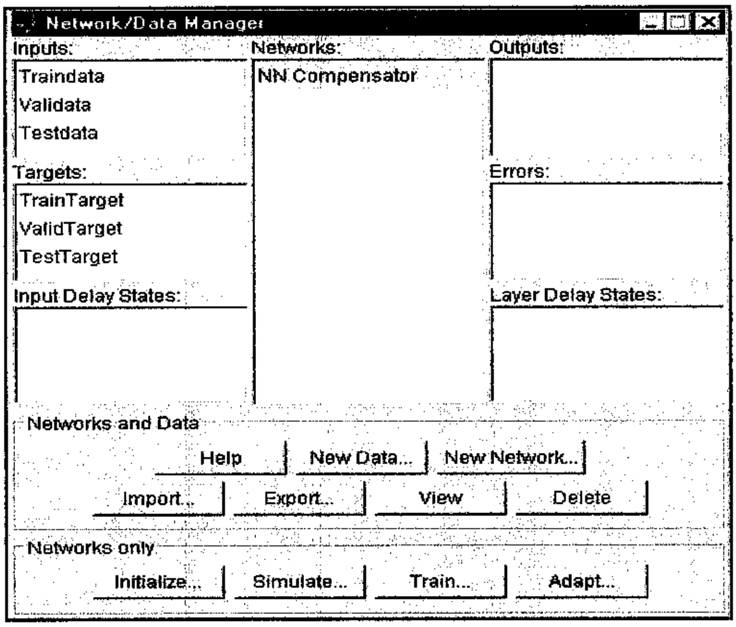


Figure 14 : GUI of the Network/Data Manager

At the same times, the NN Model is created as in figure 15. There are several parameters that have to be set in the NN Model. This includes the number of hidden layers of NN, training function, performance function, and adaptation-learning function. These parameters are selected in trial and error form until the best configuration is achieved that the Neural Network reach to a minimal of errors between the output and the target at the end of the training.

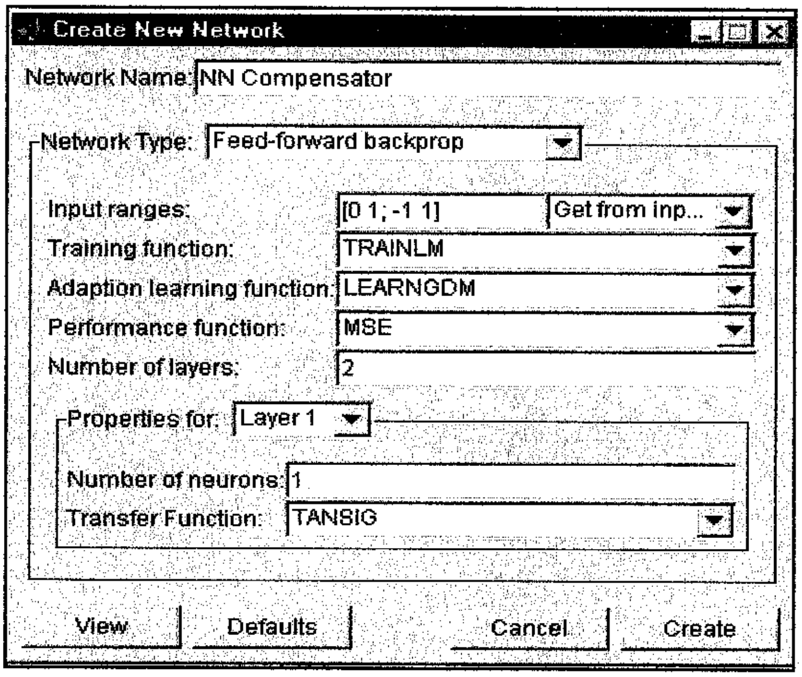


Figure 15 : GUI to create the structure of Neural Network

Neural Network Validation and Testing

In determining the best suitable network, the validation and testing set must be used together with the training data to evaluate the performance of the Network. A performance curve will be displayed once the training is started. The best case is that the line representing the validation data and testing data is below the line of the training data. Normally, this is very hard to be achieved. Most of the case, the optimum NN model is selected that gives the minimal error for both training and validation sets. Yet, the training set must be converged at the first place to a minimum value. The minimum value in this case has been set to be 1% of MSE.

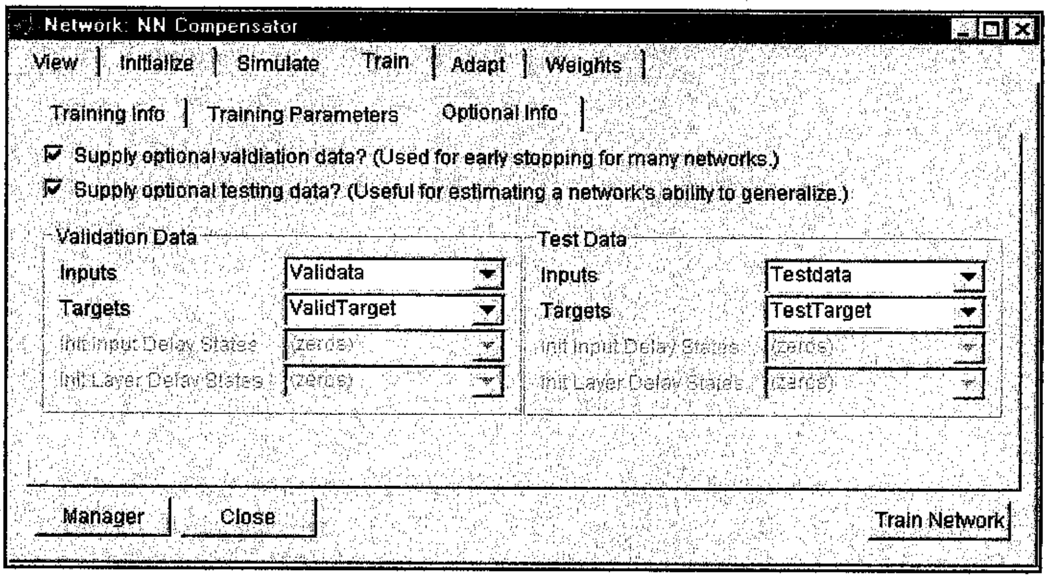


Figure 16 : Inserting the Validation and Testing Set to the training

Testing of error

Error test is used to calculate the Mean Square Error (MSE) between predicted and actual plant data. In MSE, the error of the variation between predicted and actual is squared, and summed up, and lastly divides by the number of data point. The target of the MSE for the testing set has been set to be least than 5%. The formula to calculate MSE is shown:

MSE = sum ((predicted value-actual value) ^2)/number of data) ----- (3.2)

Graphical User Interface (GUI)

Graphical User Interface (GUI) is created to make the program more use-friendly. There are four graphs that used to plot (1) Test compensator, (2) 2-D stable region, (3) 3-D stable region, and (4) Optimum tuned step response.

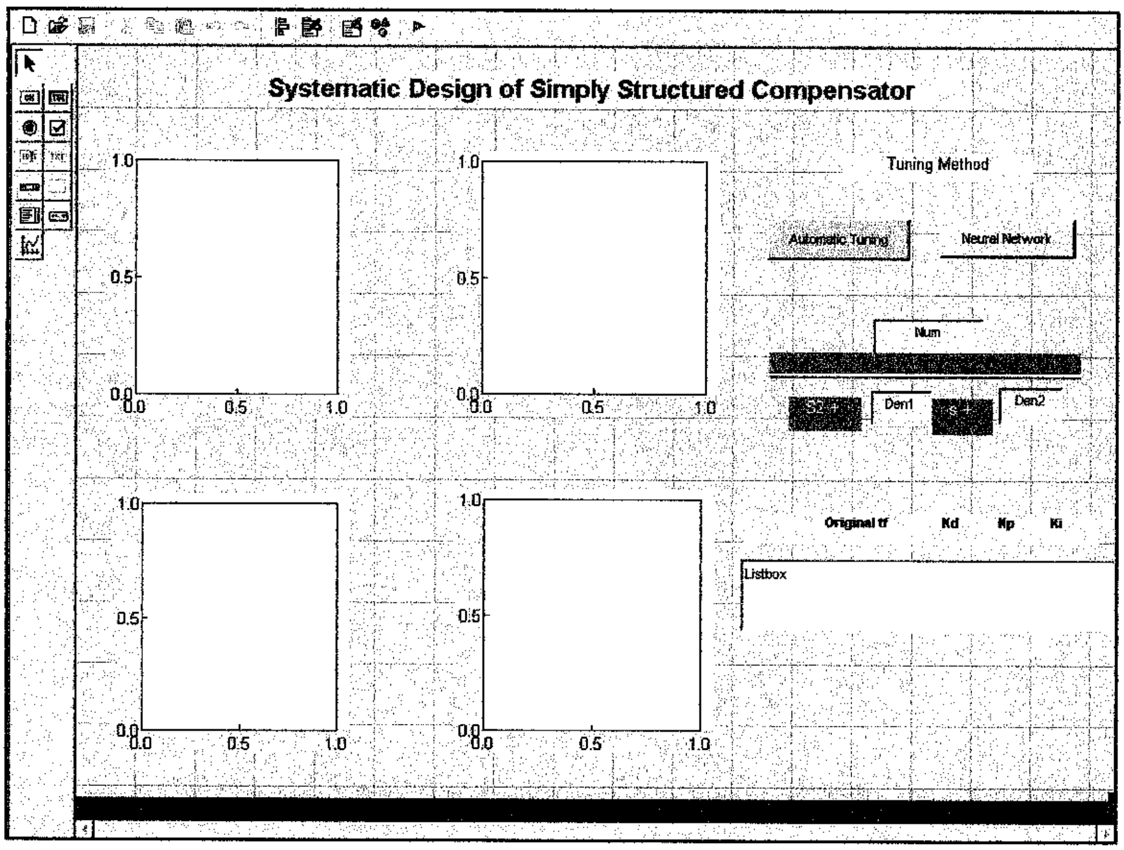


Figure 17 : Layout Editor of the Graphical User Interface

3.3 Tools

This project mainly involves the simulation results that require only softwares that include:

Matlab 6.1 - It will be the main program in this project. Matlab is used to perform calculation, plotting and also training the NN. There are many additional features that are exploited such as FFT function, square pulse generation and linear simulation. Apart from that, Matlab GUIDE is used to create an interface panel for controlling the execution of the program.

Microsoft Excel - Microsoft Excel program are mainly used in the data processing part. The data stored in the Microsoft Excel format can be interpreted in the Matlab.

CHAPTER 4
RESULTS AND DISCUSSION

The following transfer function is inserted into the program written in m-file of Matlab:

$$G(s)sys = \frac{76}{s^2 + 54s + 9}$$

4.1 Optimal Tuning Based on Nyquist Stability Criterion

4.1.1 Obtaining Stable Region

At each fixed layer of K_d value, a test compensator is set up as in Figure 17 that comprises of 30 test points. The value of K_d (z-axis value) is ranging from K_d = -7 to K_d = 5 and the process starts from the bottom layers with K_d = -7. The test compensator will be the base in obtaining the stable region.

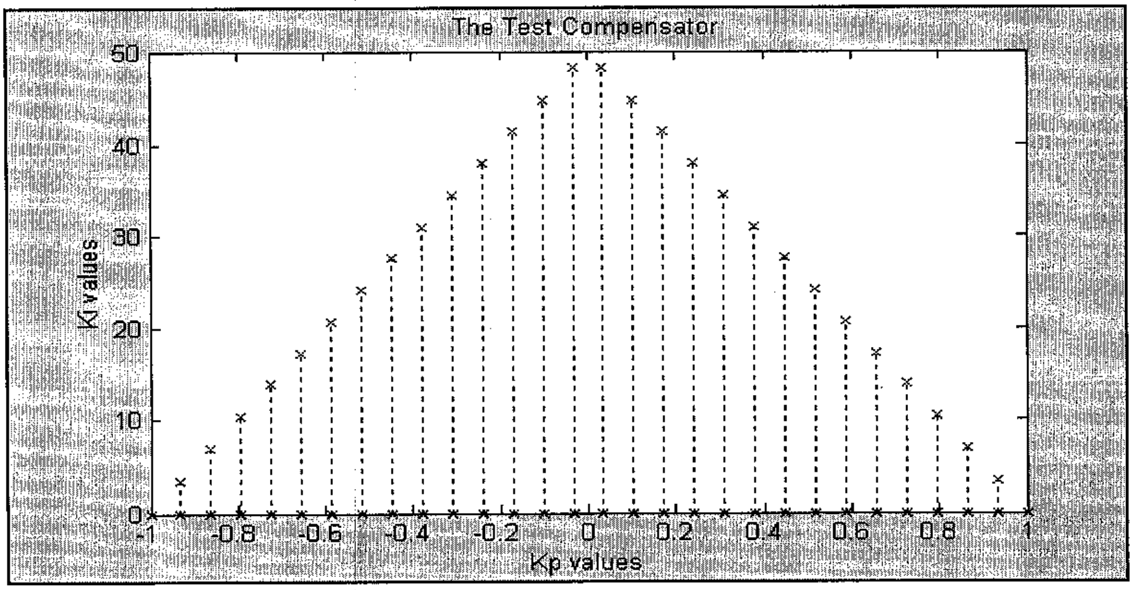


Figure 18 : The Test Compensator Plot

For explanation purpose, let's consider the layer of K_d = 0. From the test compensator, the left-most test point is selected as the first test point $[K_i, K_p, K_d]$ = [0, -0.9999, 0]. After analyzing the closed-loop system with Nyquist Stability Criterion, the gain margin obtained for the closed-loop system is 0.1184. Multiplying the gain margin with the test point, the end point is, *end point* = [0, -0.1184, 0]. The tuning parameters of the PID controller can be any values from [0, 0, 0] to the *end point*, [0, -0.1184, 0] and the system will remain stable. The process is repeated for other test points until finished. Having joined all the calculated test point for the layer of $K_d = 0$, the stable region for $K_d = 0$ is shown below.

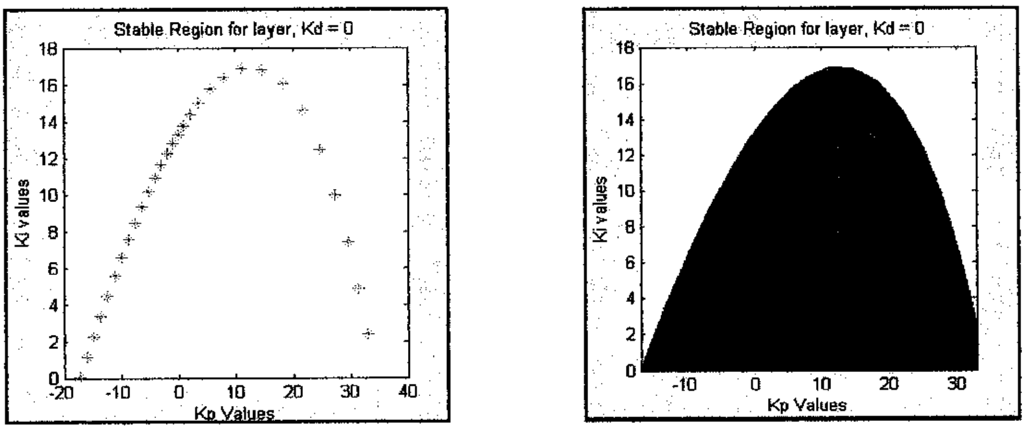


Figure 19 : The plot of the stable region for layer of $K_d = 0$*

The same procedure is repeated for other layer of K_d. At the end, all the layers are stacked on top of each other to obtain the 3-D stable region.

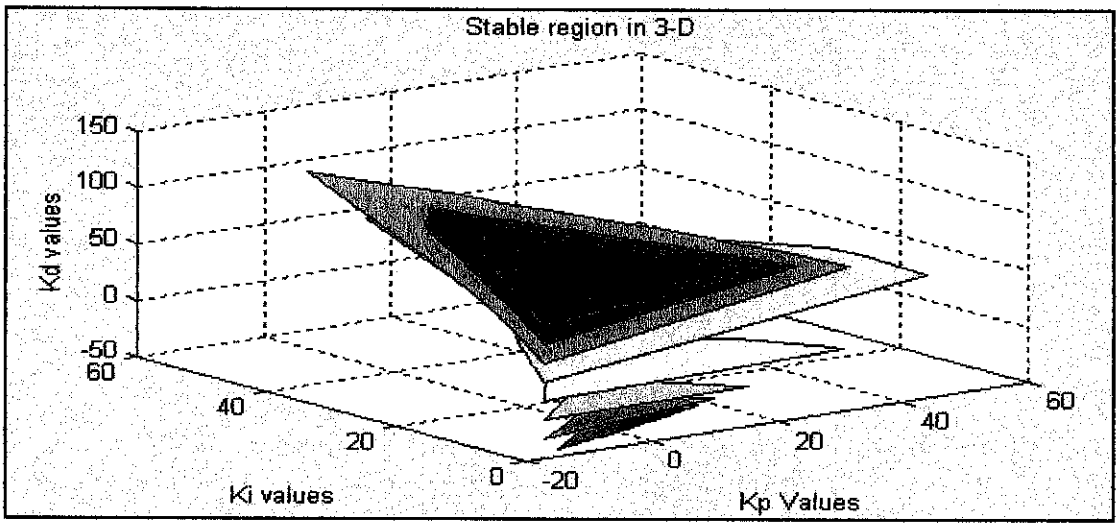


Figure 20 : The stable region of the transfer function*

* *The figure is for illustration purpose only and does not correspond to the given transfer function.*

4.1.2 Optimum Point tuning for the PID controller

From the stable region, optimal search begins by searching the best starting point within the stable region boundary. The best starting point obtained is $[K_i, K_p, K_d]$ = [0.2672, 1, 1] where the value of performance index, ITAE = 41.1475. Substituting the best starting point to the equation (1.1), the transfer function of the PID controller is as:

$$C(s)_{starting} = \frac{s^2 + s + 0.2672}{s}$$

Then only the search for the optimum tuning parameters begins. It started from the BestStarting point and will search at the *x-y-z* axis direction for optimum point. The final optimum point obtained is $[K_i, K_p, K_d]$ = [1.2672, 21, 3.5] with the value of performance index, ITAE improved from the previous one to 8.3552. The optimum closed-looped transfer function is given as:

$$G(s) = \frac{266s^2 + 1596s + 96.31}{s^3 + 320s^2 + 1605s + 96.31}$$

The step response is plotted for the closed-loop system after fine-tune:

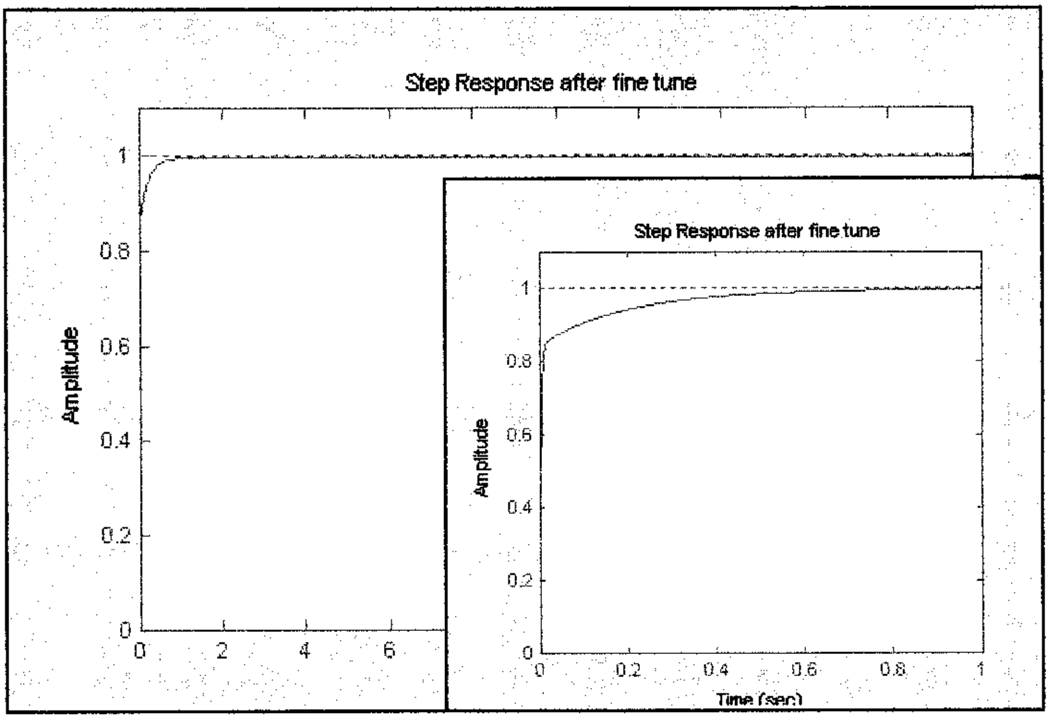


Figure 21 : Step response of the system tuned with optimum point

From the graph, the closed-loop system has fast dynamics; short rise time and settling times. The percentage of overshoot and undershoot are small. The output response has been very satisfactory.

4.2 Neural Network

4.2.1 Data Processing

Data Segmentation

The following data in Table 2 is the truncated data of segmented data of variables *a, b and c*. There are 772 sets of data of variables *a, b* and *c* that has to be segmented into three categories namely training, validation and testing set. The segmentation of the data are based on the random number of variable *a*. The complete segmented data sets for training, validation and testing is shown in Appendix.

Table 2 : Truncated of the random data

Group	*a*	*b*	*c*
Tr	1.1	81.4	28.7
Tr	1.2	79.8	75.8
Tr	1.3	51.6	55.9
Va	1.4	74.1	74.8
	⋮	⋮	
Va	98.1	49.7	51.5
Tr	98.2	18.0	58.4
Te	98.3	33.1	56.0

Notation :

Tr – Training Set

Va – Validation Set

Te – Testing Set

ANOVA Test

From the result, the average and variance of the original sets and random number are almost the same of about 50 and 800 respectively. This verifies that the segmented sets are from the same original set. The test result for the ANOVA test conducted on the variables *a* is shown in Table 3.

Table 3 : ANOVA Test Result for variable a

Anova: Single Factor_variable *a*

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	772	38947.1	50.44961	794.7126
Column 2	333	16455.2	49.41501502	811.5081
Column 3	333	16362.2	49.13573574	792.3726
Column 4	106	6129.2	57.82264151	700.4924

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	6693.614	3	2231.204	2.819295	0.037784	2.610683
Within Groups	1218763.6	1540	791.4049			
Total	1225457.2	1543				

The complete result for ANOVA Test can be referred to Appendix.

Normal Distribution Test

The Normal Distribution test is tested on the input and output properties using "Microsft Excel-Descriptive Statistics". Overall from the result of normal distribution of 64 input properties and 3 outputs, the data are normally distributed as the value of skewness and kurtosis were small attesting to the normality of the distribution. The result for the Input Properties 1 is shown below.

Table 4 : Normal Distribution Test result for Input Properties 1

Input Properties 1	
Mean	126.41057
Standard Error	0.7368375
Median	129.1822
Mode	#N/A
Standard Deviation	20.472948
Sample Variance	419.1416
Kurtosis	1.4386498
Skewness	-0.7832241
Range	139.706
Minimum	47.6382
Maximum	187.3442
Sum	97588.962
Count	772
Confidence Level(95.0%)	1.4464447

The complete result for Normal Distribution Test is shown in Appendix.

4.2.2 Neural Network Construction and Training

Neural Network Training

The training of the Neural Network has been trained with different structures of Neural Networks. The optimum structure of NN for each of the three types of controller is the one, which gives the smallest Mean Square Error (MSE) for the training and the validation set. For all the cases, the neurons in the hidden layers are sigmoid type and the training algorithm is the resilient backpropagation.

Table 5 : Summary Results of NN training

P Controller	**No. Neuron**	**Training**	**Validation**
	20_30_30	0.079%	4.68%
	30_30_30	0.078%	4.02%
	40_30_30	0.087%	4.79%
I Controller	**No. Neuron**	**Training**	**Validation**
	30_40_40	1.0%	2.7%
	40_40_40	0.78%	4.02%
	50_40_40	0.87%	4.79%
D Controller	**No. Neuron**	**Training**	**Validation**
	30_40_40	0.83%	5.09%
	40_40_40	0.8%	5.37%
	50_40_40	0.85%	5.56%

For P controller, the architecture of NN with 30_30_30 neurons in the hidden layer is chosen to be the optimum point. It gives the smallest for both the training and validation sets.

Meanwhile for I controller, the optimum configuration is the structure with 30_40_40 neuron of sigmoid in the hidden layer. Although the structure of 40_40_40 and 50_40_40 give smaller of MSE for the training sets, the MSE of the validation set of the configuration with 30_40_40 neurons is the smaller than the other two. After all the MSE of the training set is only slightly different. Again, the optimum configuration for D controller is the one with 30_40_40 neurons in the hidden layer because it has the smallest of MSE for validation set although it doesn't have the smallest compared to the other structure of NN.

The line representing validation can't be included in the training because it terminates the training process before it reaches the desired number of epochs. Thus, it is opted to calculate the MSE manually at the end of the training.

The graphs of convergence for the Optimum NN Structure of P, I and D controllers respectively are shown:

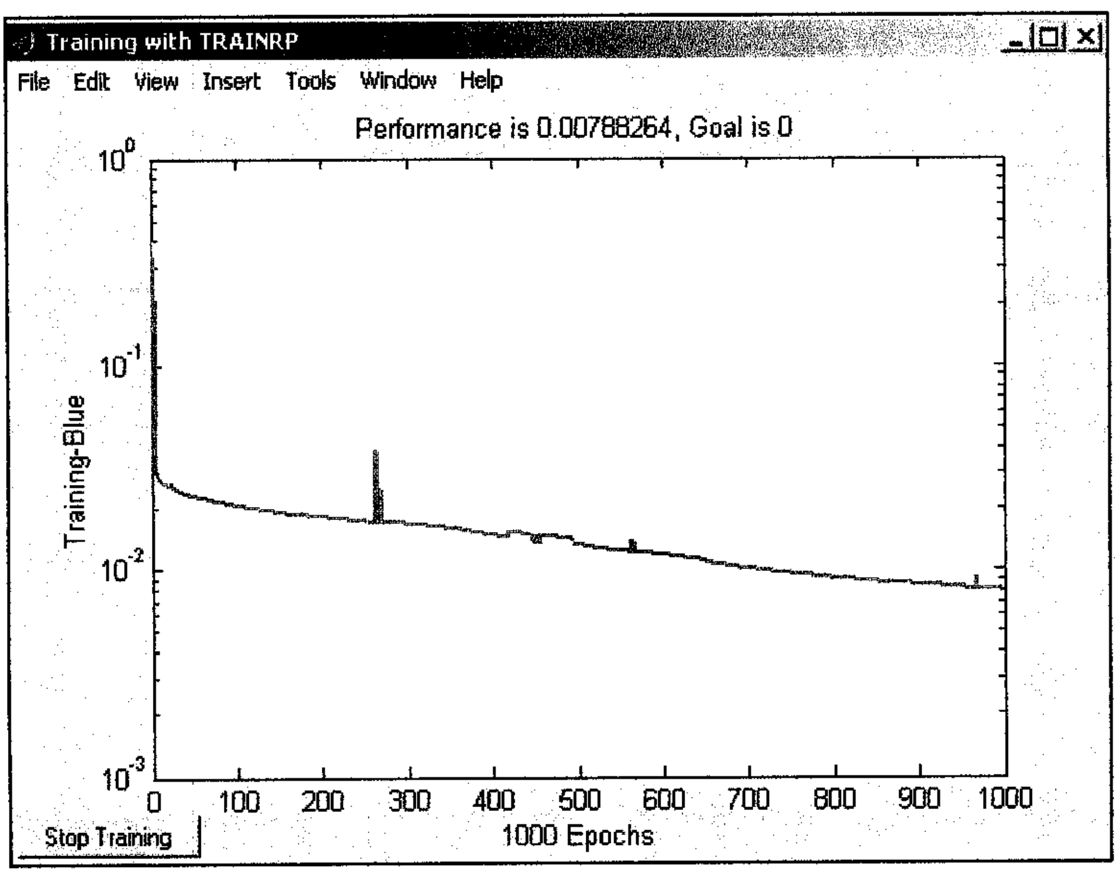


Figure 22 : The convergence graph for P controller

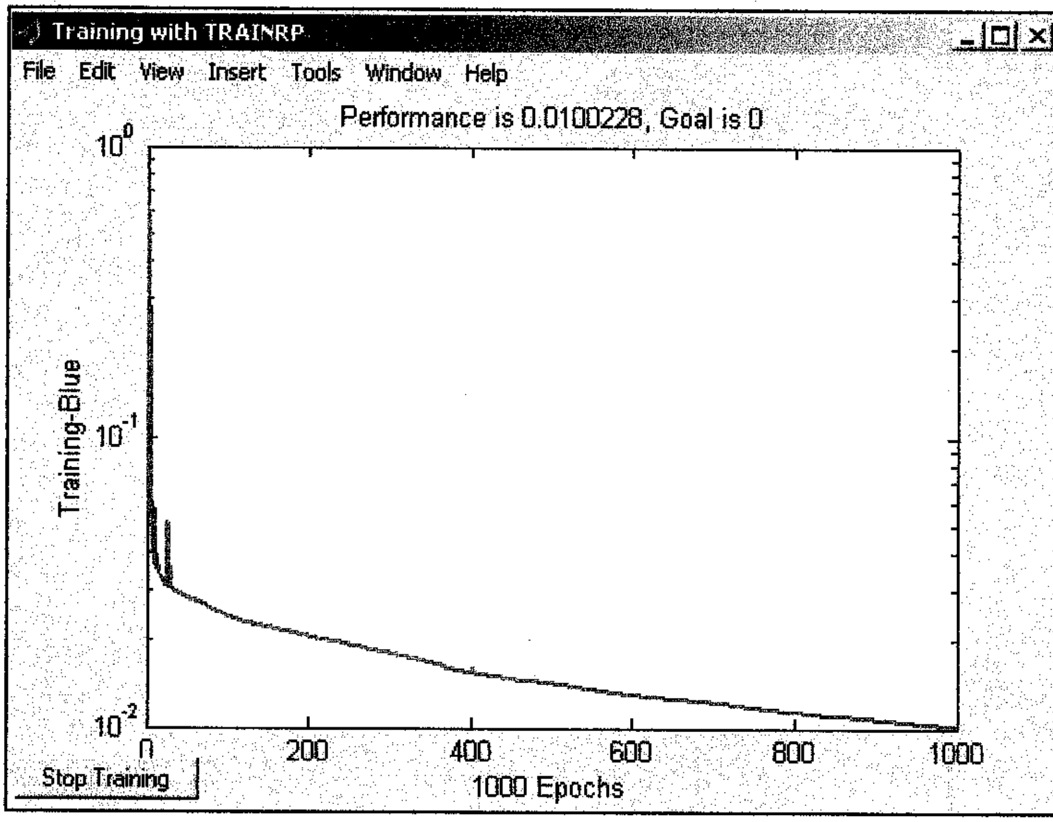


Figure 23 : The convergence graph for I controller

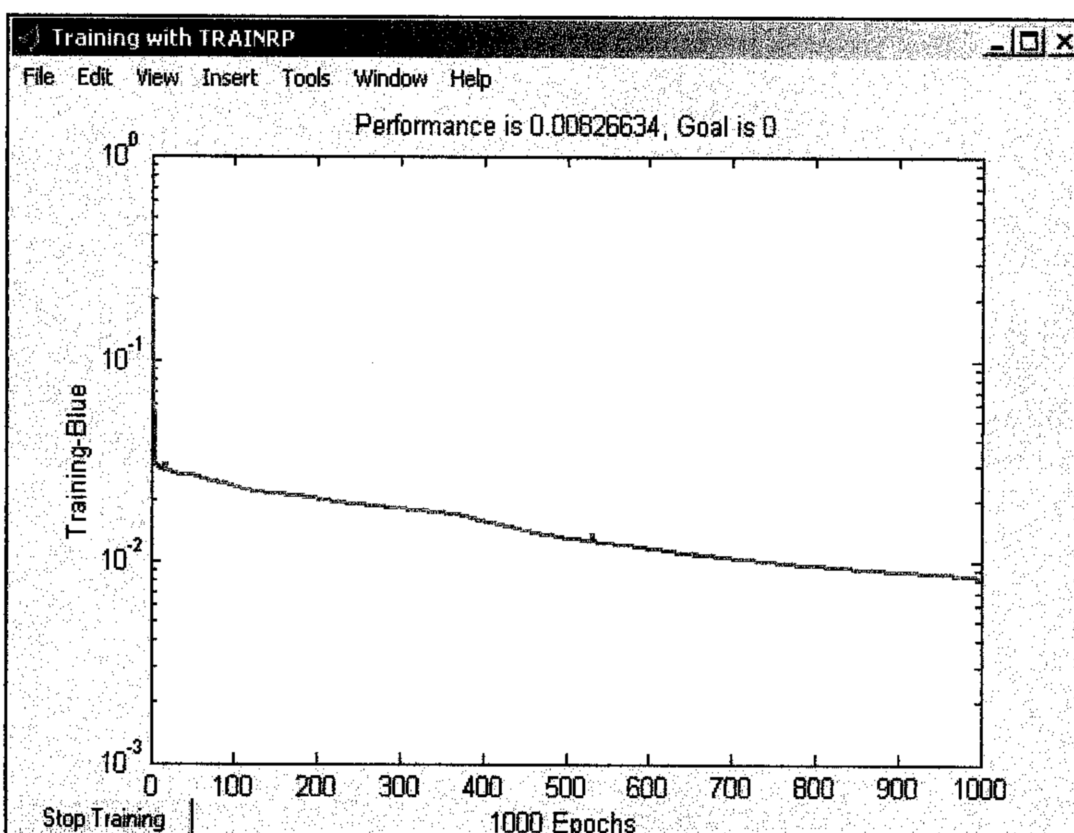


Figure 24 : The convergence graph for D controller

Testing Data

The true performance should be based on test data [8]. The results of the MSE obtained from the predicted output of P controller on the testing data is 2.7 %. Meanwhile, the MSE for I controller and D controller is 3.3 %, and 4.1 % respectively. All of the results are below 5% of MSE. The P and I controllers are more robust than D controller. D controller is more prone to errors. The complete result for Neural Network Training can be referred to Appendix F.

Table 6 : Summary Results MSE of Testing Set

Type	MSE
P_controller	2.7%
I_controller	3.3%
D_controller	4.1%

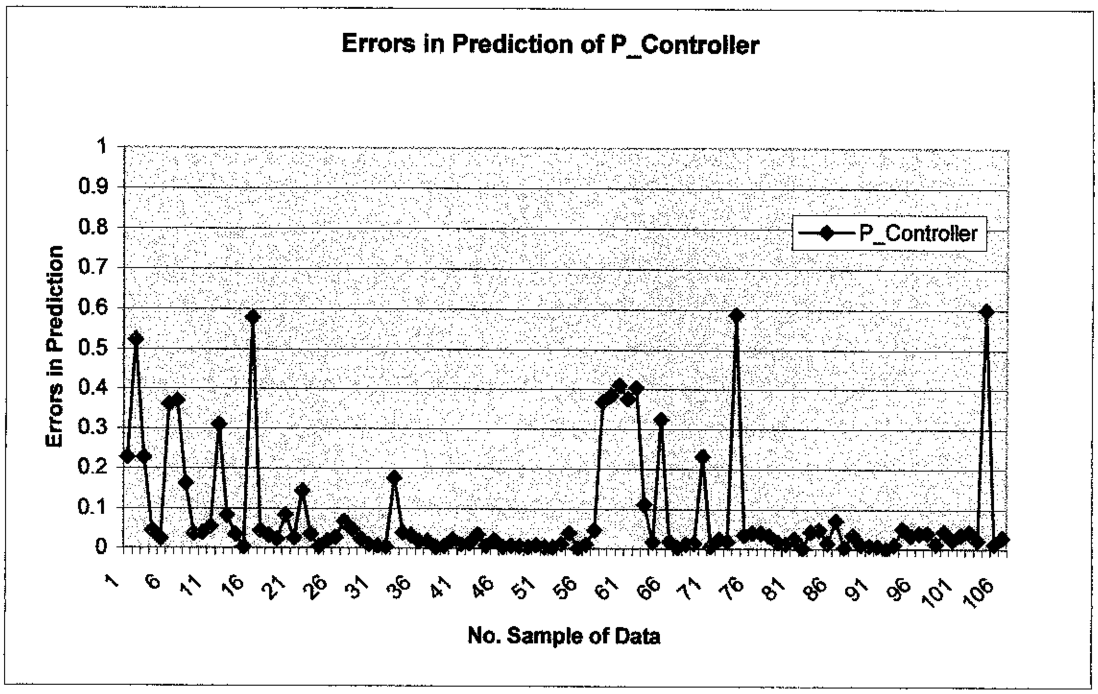


Figure 25 : Errors in prediction of P controller

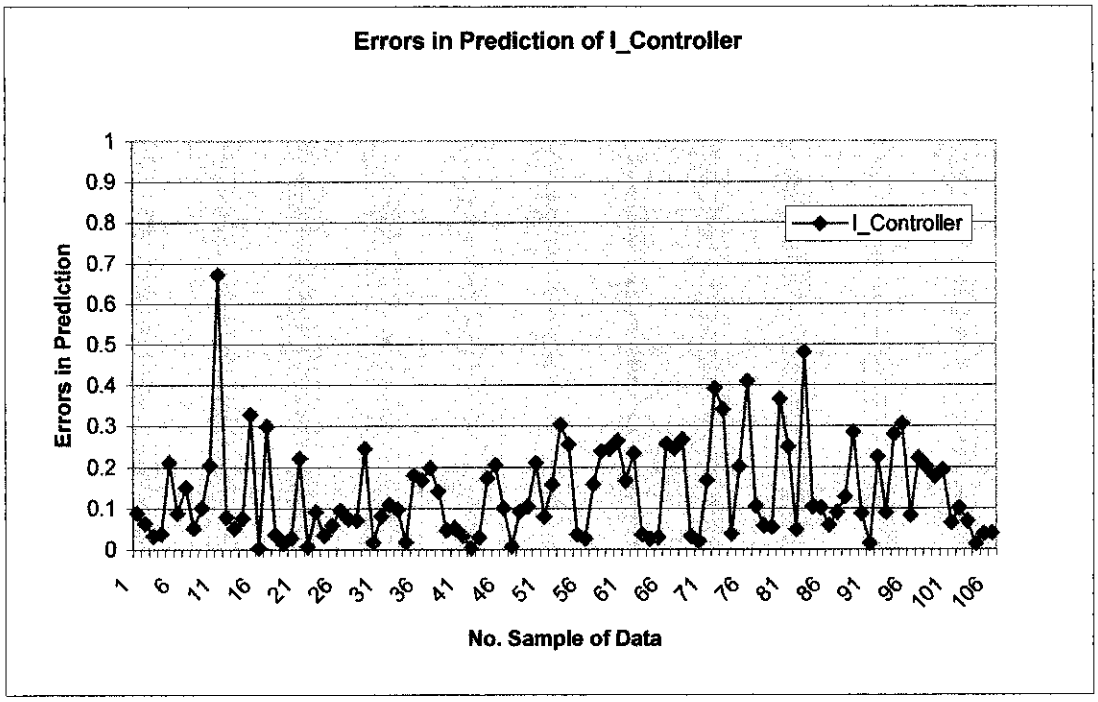


Figure 26 : Errors in prediction of I controller

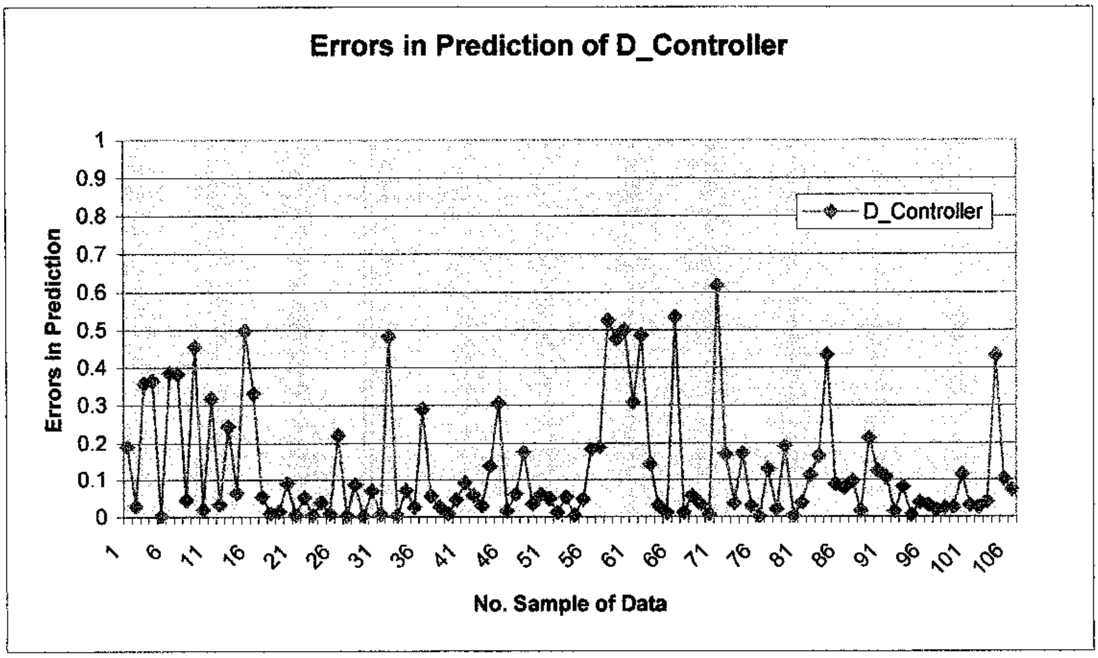


Figure 27 : Errors in prediction of D controller

Graphical User Interface

The developed GUI is used so that the user is easier to handle the program. Here is the front panel for the GUI. The user can select either the automation tuning or using the neural network for fine-tuning. Before that, the user has to enter the values of the second order function. The result is displayed in the text box. Meanwhile, the graphs of test compensator, 2-D stable region, 3-D stable region and also the step response of the optimum tuning of closed-loop system is plotted in the four plots.

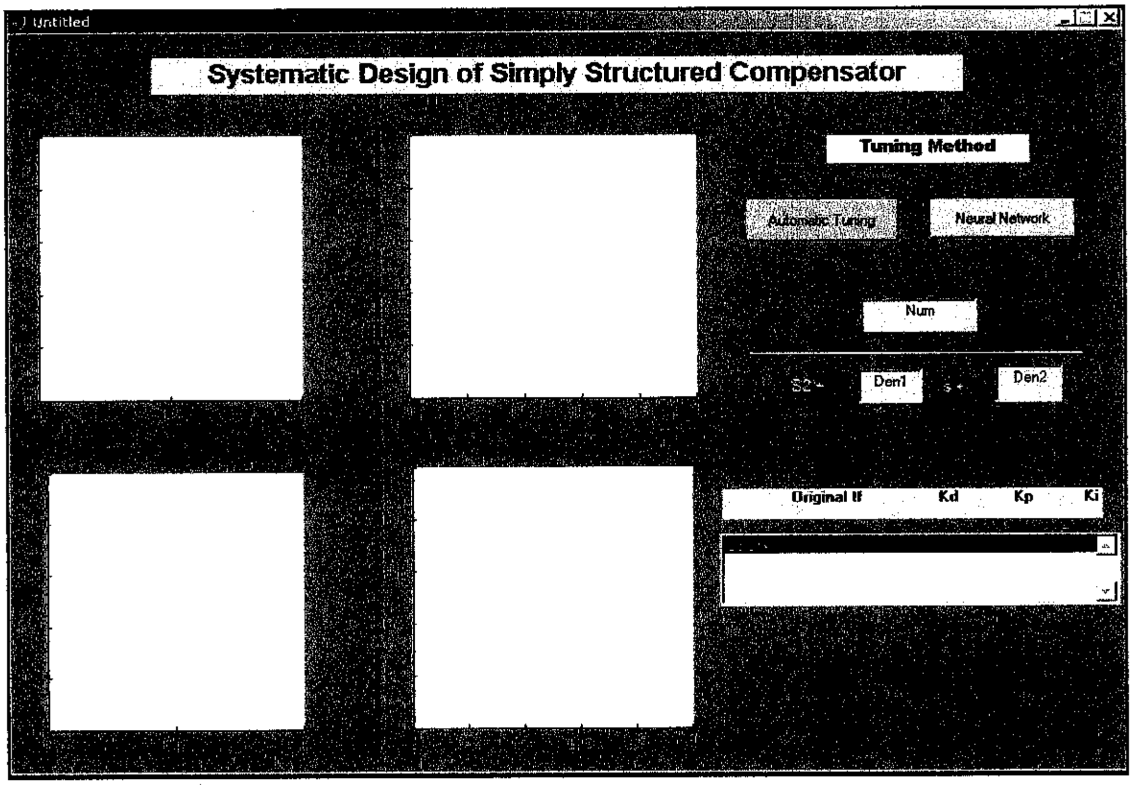


Figure 28 : Layout of the GUI front panel

Improvement Strategies

Overall, the NN structure still has errors. Improvement can be done to make it more robust for the NN in predicting the output. Various improvements strategies can be implemented that include:

- Increase the number of inputs
- Increase the number of epochs
- Increase the number of layers
- Use a different learning algorithm, trainlm

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This project is concerned with techniques of fine-tuning the PID controller for the usage in the process control application.

The tuning rule based on the Nyquist Stability Criterion as demonstrated from the developed program has able to fine tune the PID controller to output a satisfactory step response for the closed-loop system. This reflects that the Nyquist approach is potentially to be developed into the major techniques of fine-tuning the PID controller.

On the other hand, NN model developed based the data obtained from Nyquist Stability Criterion has further extended the capabilities of the tuning process. The tuning is based on directly from the frequency response of the system to the square pulse testing, which is more robust. The target of 5% MSE for the prediction has been achieved.

Lastly, a GUI for the program has been developed to make the program more user-friendly.

5.2 Recommendation

At the present, the project work is concerned with the single-input single-output (SISO) continuous time system. Most of the real-life applications involve multi-input multi-output (MIMO) system. It would be useful to expand the work towards this type of system.

The second suggestion is that in the future work to cater the time delay that occurred in the system. Time delays occur in control system when there is a delay between the commanded response and the start of the output response. Thus, it will be important to include analysis on the time delay.

Lastly, the neural network model can still be refined to be more robust. It will be better if it can be tested in the real plant and incorporate other parameters apart from the frequency response such as temperature, flow rate and pressure as the inputs for the NN.

REFERENCES

[1] Guillermo J.Silva, Aniruddha Datta, and S. P. Bhattacharya, "New Results on the Synthesis of PID Controllers", IEEE Transactions on automatic control, VOL 47, No. 2, February 2002.

[2] Dr.M.J.Willis, "Proportional – Integral - Derivative Control", University of Newcastle.

[3] Zazilah May, " Design of a simply Structure Compensator", MSc in Advanced Control Thesis, University of Manchester Institute of Science and Technology, United Kingdom, September 2000.

[4] Prof. Marzuki Khalid,"Artificial Neural Network, Multilayer Neural Network and Backpropagation Algorithm Module 3", Universiti Teknologi Malaysia.

[5] V.R. Radhakrishnan and A.R Mohamed, 2000, "Neural Network for the identification and Control of Blast Furnace Hot Metal Quality", Journal of Process Control 10(2000):509-524.

[6] L.C. Hamilton,"Modern Data Analysis - A first Course of Applied Statistics", Brooks/Cole, 1990.

[7] V. R Radhakrishnan, "Soft Sensors for the cement industry,-Neural Network Models for kiln and grinding mill", Platform - Universiti Teknologi PETRONAS Journals, July-Dec 2003 edition.

[8] William L. Luyben, "Process Modelling, Simulation and Control for Chemical Engineers, Second Edition", McGraw Hill Inc.

[9] A.H.S Maulud, I.Ismail, R.D. Menez and M.A.Shafawi, "Industrial Stream Composition Forecasting Using Neural Ntework", Platform - Universiti Teknologi PETRONAS Journals, Jan-June 2003 edition.

[10] K.Astrom and T.Hagglund, " PID Controllers: Theory, Design, and Tuning ", Instrument Society of America Publication, 2nd edition, 1995.

[11] Hau Shu, " PID Neural Networks for complex system", Proceeding of 2002 IEEE Conf. on Intelligent Control.

[12] V M Becerra, K Pirabakaran "Automatic tuning of PID controllers using neural networks", The University of Reading, 2000.

[13] Ankit Raizada & Vishal Bhatnagar, "Neural Network Based PID Controllers", Indian Institute of Information Technology, Allaabad.

[14] Hagan, Demuth and Beale "Neural Network Design", PWS Publishing Company, 1996.

APPENDICES

APPENDIX A

M-FILE FOR FINE TUNING METHOD

```
% For PI controller (22 Sept 2004)
% To find the starting point for Optimization
% look for the negative values of performance index: Done use absolute
% look for dummy value =0
% solve the looping
% modified level:2 (22sept 2004)
% modified level:3 (25 sept 2004)
% looks for undershoot
% looks for feedback
% modified level 4: (30 Sept 2004) on the Kd level
% modified level 5: (30 Sept 2004) on the Kd level
% Integration of the limit(8th October 2004)
% Getting the data to train the neural network (8th of December 2004)
% Started to train the network : 27 Dec 2004
% Not successful wt the sequence numbers
% try to use random  number
%Fina : Data Generation for the output variables in the NN
%*********************************************************************

clear
traindata=0;
stages=0;
pq=0;
load abc

for testpoint=1:1:14

      numg=[Testing(testpoint,1)];
      deng=[1 Testing(testpoint,2) Testing(testpoint,3)];
      Gp=tf(numg,deng);
      p=abs(real(pole(Gp)));
      n=length(p);
      tmin=0;
      tmax=100;
      N=0.1;
      tt=tmin:N:tmax;


      %   Note: This program is restricted to 5 open-loop system forward path poles!

      data1=zeros(length(p),2);
      data2=zeros(length(p),2);
```

```
%   For the User to setup the requirement

a=0;
definedOs=30;
definedOs2=30;
definedUs=30;
definedUs2=30;
nostep=5;



% ***********************************
%           Best Starting Module
% ***********************************


for m=1:1:length(p)

    s1=[p(m)-0.1];
    numc1=[1 1 s1];
    denc1=[1 0];
    Gc1=tf(numc1,denc1);
    G1=Gp*Gc1;
    y1=step(feedback(G1,1),tt);
    y1min=min(y1);
    [y1max,tmax1]=max(y1(:,1));
    overshoot=100*(y1max-y1(end))/y1(end);
    undershoot=abs(100*y1min);
    yy1=lsim(feedback(G1,1),tt,tt);
    vitae=sum(N.*(tt'-yy1)');

    %   restriction in the percentage of overshoot & undershoot

    if (overshoot <= definedOs2) & (undershoot <= definedUs2)
            a=a+1;
            s_point(a)=s1;
            p_overshoot(a)=overshoot;
            vit(a)=vitae;

    end

    %*********************************************

     s2=[p(m)+0.1];
     numc2=[1 1 s2];
     denc2=[1 0];
    Gc2=tf(numc2,denc2);
    G2=Gp*Gc2;
    y2=step(feedback(G2,1),tt);
    [y2max,tmax]=max(y2(:,1));
    overshoot=100*(y2max-y2(end))/y2(end);
    undershoot=abs(100*y1min);
```

```
    yy2=lsim(feedback(G2,1),tt,tt);
    vitae=sum(N.*(tt'-yy2)');

    %       restriction in the percentage of overshoot & undershoot

      if (overshoot <= definedOs2) & (undershoot <= definedUs2)
              a=a+1;
              s_point(a)=s2;
              p_overshoot(a)=overshoot;
              vit(a)=vitae;
      end

      %*********************************************

end

% Searching for the minimum ITAE and percentage of overshoot

dummyV=max(a);

if dummyV ~= 0
      ITAEV1A=min(vit);

      for loop=1:1:dummyV

          if vit(loop) = = ITAEV1A
                start_point(2)=s_point(loop);
                percentage_oversoot=p_overshoot(loop);
                ITAEV1A = vit(loop);
          end
      end
else
         start_point(2)=s2;
         ITAEV1A = vitae;
end

start_point(1)=1;
numstart= [1 start_point(1) start_point(2)]
Gstart=tf(numstart,[1 0])
Gstart2=Gp*Gstart;
t=0:0.05:20;
step(feedback(Gstart2,1),t);
ITAEV1ARef=ITAEV1A
startpointRef=start_point(2);
ReferenceITAE=ITAEV1A;
d=1;
```

```
%*********************************
%            Optimum Search
%*********************************

for stage=1:1:5

    m=0;
    startpointRef=start_point(2);
    ReferenceITAE=ITAEV1A;


    %*********************************
   %      Start of y-axis search
    %*********************************

    % Positive Direction


     for a=1:1:nostep

          start_point(3)= start_point(2);
          start_point(2)= start_point(2)+ 1.0;
          numc1=[d start_point(1) start_point(2)];
          denc1=[1 0];
          Gc1=tf(numc1,denc1);
          G2=Gp*Gc1;
          y2=step(feedback(G2,1),tt);
          [y2max,tmax]=max(y2(:,1));
          Subovershoot=100*(y2max-y2(end))/y2(end);
          undershoot=abs(100*y1min);
          yy2=lsim(feedback(G2,1),tt,tt);
          NewITAE=abs(sum(N.*(tt'-yy2)'));
          NewIndexITAE(a)= NewITAE;


          %          insert of limitation on the boundary

          if a~=1 & y2max > 30
               break;
          end

          if a = =1 & y2max > 30
               NewIndexITAE(1)= startpointRef+1;
               break;
          end

          % *********************************
```

```
if NewITAE >= (ITAEV1A -15)
        start_point(2)= start_point(3);
        break
end


%       restriction in the percentage of overshoot & undershoot

if (Subovershoot <= definedOs) & (undershoot <= definedUs)
          Subovershoot;
          m=m+1;
          NewITAEinner1(m)=NewITAE;
          Newstartpoint_21(m)= start_point(2);
end

%  ***********************************************

          ITAEV1A = NewITAE;

end


Dummy_Value=max(m);

if Dummy_Value ~ = 0
        MinITAE=min(NewITAEinner1);

        for a=1:1:Dummy_Value
                if  NewITAEinner1(a)== MinITAE
                        ITAEV1A=NewITAEinner1(a);
                        start_point(2)=Newstartpoint_21(a);
                end
         end

else
          start_point(2)=startpointRef;
          ITAEV1A=ReferenceITAE;

end


 %     Negative Direction

startpointRef=start_point(2);
ReferenceITAE=ITAEV1A;
m=0;
```

```
% compare the first values of the loop

if NewIndexITAE(1)>=ITAEV1ARef

    for a=1:1:nostep

            start_point(3)= start_point(2);
            start_point(2)= start_point(2)- 1.0;
            numc1=[d start_point(1) start_point(2)];
            denc1=[1 0];
            Gc1=tf(numc1,denc1);
            G2=Gp*Gc1;
             y2=step(feedback(G2,1),tt);
             [y2max,tmax]=max(y2(:,1));
             Subovershoot=100*(y2max-y2(end))/y2(end);
             undershoot=abs(100*y1min);
             yy2=lsim(feedback(G2,1),tt,tt);
             NewITAE=abs(sum(N.*(tt'-yy2)'));


          %     restriction on the boundary

          if y2max > 30
                break;
        end

           % ************************

           if NewITAE >= (ITAEV1A -5)
                start_point(2)= start_point(3);
                break;
           end


           %    restriction in the percentage of overshoot & undershoot

           if (Subovershoot <= definedOs) & (undershoot <= definedUs)
                 m=m+1;
                Subovershoot;
                 NewITAEinner1(m)=NewITAE;
                 Newstartpoint_21(m)= start_point(2);
            end

             %********************************************

             ITAEV1A = NewITAE ;
        end

end

%**********************     end of y-axis search     ******************
```

```
Dummy_Value=max(m);

 if Dummy_Value~=0
        for a=1:1:Dummy_Value
                MinITAE=min(NewITAEinner1);

                if NewITAEinner1(a)== MinITAE
                    ITAEV1A=NewITAEinner1(a);
                    start_point(2)=Newstartpoint_21(a);
                end

        end
 else

      start_point(2)=startpointRef;
      ITAEV1A=ReferenceITAE;

 end


ITAEV1ARef2=ITAEV1A;

 %*********************************************
 %                    Start of X-axis search
 %*********************************************

 m=0;
 startpointRef=start_point(1);
 ReferenceITAE=ITAEV1A;

 for a=1:1:nostep

      %     Positive Direction

      start_point(3)= start_point(1);
      start_point(1)= start_point(1)+ 2.0;
      numc1=[d start_point(1) start_point(2)];
      denc1=[1 0];
      Gc1=tf(numc1,denc1);
      G2=Gp*Gc1;
      y2=step(feedback(G2,1),tt);
      [y2max,tmax]=max(y2(:,1));
      Subovershoot=100*(y2max-y2(end))/y2(end);
      undershoot=abs(100*y1min);
      yy2=lsim(feedback(G2,1),tt,tt);
      NewITAE=abs(sum(N.*(tt'-yy2)'));
      NewIndexITAE2(a)= NewITAE;
      pq=pq+1;
      Diff(pq)=NewITAE-ITAEV1A;

      %     insert of limitation on the boundary
```

```
 if a~=1 & y2max > 30
        break;
end

if  a = =1 & y2max > 30
        NewIndexITAE(1)= startpointRef+1;
        break;
end

%  ********************************

if   a = = 3 | a = = 4 | a = = 5
       if NewITAE >= (ITAEV1A-0.3)
              start_point(1)= start_point(3);
              break;
       end
end


if  NewITAE >= ITAEV1A+20.0
     start_point(1)= start_point(3);
     break;
end

%    restriction in the percentage of overshoot & undershoot

  if (Subovershoot <= definedOs) & (undershoot <= definedUs)
       m=m+1;
       Subovershoot;
       NewITAEinner2(m)=NewITAE;
       Newstartpoint_22(m)= start_point(1);
   end

   %********************************************

  ITAEV1A = NewITAE;

end

 %**************************************************

Dummy_Value=max(m);

if Dummy_Value ~ = 0
       MinITAE = min(NewITAEinner2);
        for a=1:1:Dummy_Value
               if  NewITAEinner2(a) = = MinITAE
                      ITAEV1A=NewITAEinner2(a);
                      start_point(1)=Newstartpoint_22(a);
               end

        end
```

```
else
        start_point(1)=startpointRef;
        ITAEV1A=ReferenceITAE;
end

%     Negative Direction

m=0;
startpointRef=start_point(1);
ReferenceITAE=ITAEV1A;
NewIndexITAE2(1);
ITAEV1ARef2;

if NewIndexITAE2(1)>=ITAEV1ARef2
      for a=1:1:nostep

            start_point(3)= start_point(1) ;
            start_point(1)= start_point(3)- 2.0;
            numc1=[d start_point(1) start_point(2)];
            denc1=[1 0];
            Gc1=tf(numc1,denc1);
            G2=Gp*Gc1;
            y2=step(feedback(G2,1),tt);
            [y2max,tmax]=max(y2(:,1));
            Subovershoot=100*(y2max-y2(end))/y2(end);
            undershoot=abs(100*y1min);
            yy2=lsim(feedback(G2,1),tt,tt);
            NewITAE=abs(sum(N.*(tt'-yy2)'));


            % restriction on the boundary

            if y2max > 30
                NewIndexITAE(1)= startpointRef+1;
                break;
            end

            % ************************

         if a = =3 | a = = 4 | a = =5
               if NewITAE >= (ITAEV1A-0.1)
                     start_point(1)= start_point(3);
                     break;
               end

         end

         if NewITAE >= ITAEV1A+20.0
               start_point(1)= start_point(3);
               break;
         end
```

```
        %    restriction in the percentage of overshoot & undershoot

        if (Subovershoot <= definedOs) & (undershoot <= definedUs)
                m=m+1;
                Subovershoot;
                NewITAEinner2(m)=NewITAE;
                Newstartpoint_22(m)= start_point(1);
        end

        %*********************************************

        ITAEV1A = NewITAE ;
    end
end

%************* end on the search in x direction *************


Dummy_Value=max(m);

if Dummy_Value~=0
    MinITAE=min(NewITAEinner2);

    for a=1:1:Dummy_Value
        if NewITAEinner2(a)== MinITAE
            ITAEV1A=NewITAEinner2(a);
            start_point(1)=Newstartpoint_22(a) ;
        end
    end

else
    start_point(1)=startpointRef;
    ITAEV1A=ReferenceITAE ;
end


  %******************************************
  %              Start of z-axis search
  %******************************************
  % Positive Direction

  startpointRef=d;
  ReferenceITAE=ITAEV1A;
  m=0;

  for a=1:1:5

      start_point(3)= d;
      d= d+0.5;
      numc1=[d start_point(1) start_point(2)];
      denc1=[1 0];
      Gc1=tf(numc1,denc1);
```

```
G2=Gp*Gc1;
y2=step(feedback(G2,1),tt);
[y2max,tmax]=max(y2(:,1));
Subovershoot=100*(y2max-y2(end))/y2(end);
undershoot=abs(100*y1min);
yy2=lsim(feedback(G2,1),tt,tt);
NewITAE=abs(sum(N.*(tt'-yy2)'));
NewIndexITAE3(a)= NewITAE


%        insert of limitation on the boundary

if a~=1 & y2max > 30
        break;
end


if a = =1 & y2max > 30
        NewIndexITAE(1)= startpointRef+1;
        break;
end

% *******************************

if a = =3 | a = = 4 | a = = 5

       if NewITAE >= (ITAEV1A-0.05)
            d= start_point(3);
            break;
       end

end


% ********************************

if  NewITAE >= (ITAEV1A+30.0)
         d= start_point(3);
         break
end

%      restriction in the percentage of overshoot & undershoot

if (Subovershoot <= definedOs) & (undershoot <= definedUs)
          Subovershoot;
          m=m+1;
          NewITAEinner3(m)=NewITAE;
          Newstartpoint_23(m)= d;
end

%**********************************************
```

```
     ITAEV1A = NewITAE;
end


Dummy_Value=max(m);
     if Dummy_Value~=0
          MinITAE=min(NewITAEinner3);

            for a=1:1:Dummy_Value
                 if  NewITAEinner3(a) = = MinITAE
                      ITAEV1A=NewITAEinner3(a);
                      d=Newstartpoint_23(a);
                 end
            end

     else
            d=startpointRef;
            ITAEV1A=ReferenceITAE;
      end


     %    Negative Direction

     startpointRef=d;
     ReferenceITAE=ITAEV1A;
     m=0;


   %      compare the first values of the loop

     if  NewIndexITAE3(1)>=ITAEV1ARef
              for a=1:1:5

                start_point(3)= d;
                d= d-0.5;
                numc1=[d start_point(1) start_point(2)];
                denc1=[1 0];
                Gc1=tf(numc1,denc1);
                G2=Gp*Gc1;
                y2=step(feedback(G2,1),tt);
                [y2max,tmax]=max(y2(:,1));
                Subovershoot=100*(y2max-y2(end))/y2(end);
                undershoot=abs(100*y1min);
                yy2=lsim(feedback(G2,1),tt,tt);
                NewITAE=abs(sum(N.*(tt'-yy2)'));

              % restriction on the boundary

                if y2max > 30
                     NewIndexITAE(1)= startpointRef+1;
                     break;
                end
```

```
                % *************************************
                % restriction in the percentage of overshoot & undershoot

                if  (overshoot <= definedOs2) & (undershoot <= definedUs2)
                        a=a+1;
                        s_point(a)=s1;
                        p_overshoot(a)=overshoot;
                        vit(a)=vitae;
                 end

                %*******************************************

                if a = =3 | a = = 4 | a = = 5
                     if NewITAE >= (ITAEV1A-0.05)
                          d= start_point(3);
                            break;
                      end

                 end


                 if NewITAE >= (ITAEV1A+30.0)
                      d= start_point(3);
                      break;
                 end
                 %****************   Overshoot     *************

                 if (Subovershoot <= definedOs) & (undershoot <= definedUs)
                       m=m+1;
                       Subovershoot;
                       NewITAEinner3(m)=NewITAE;
                       Newstartpoint_23(m)= d;
                 end

                 %*************    end Overshoot    ***********

                 ITAEV1A = NewITAE;

            end

    end

    %************   end of z-axis search    **************

    Dummy_Value=max(m);

     if Dummy_Value~=0
          for a=1:1:Dummy_Value
               MinITAE=min(NewITAEinner3);

                if  NewITAEinner3(a)== MinITAE
                       ITAEV1A=NewITAEinner3(a);
```

```
                    d=Newstartpoint_23(a);
                end

            end
        else
            d=startpointRef;
            ITAEV1A=ReferenceITAE;
        end

        ITAEV1ARef2=ITAEV1A;


        %    clear all the looping variables

        clear  Newstartpoint_21
        clear  Newstartpoint_22
        clear  Newstartpoint_23
        clear  NewITAEinner1
        clear  NewITAEinner2
        clear  NewITAEinner3
        clear  NewIndexITAE1
        clear  NewIndexITAE2
        clear  NewIndexITAE3


    end

    stages=stages+1
    Gsys=feedback(Gp,1);
    Num =[d start_point(1) start_point(2)]
    Den=[1 0];
    Gcomp=tf(Num,Den)
    Gp2=Gp*Gcomp;
    Gsys2=feedback(Gp2,1)
    t=0:0.05:20;
    step(Gsys2,t);


    %**************    Optimum Values    **************

     traindata=traindata+1;
     OptimumData(1,traindata)= Num(1);
     OptimumData(2,traindata)= Num(2);
     OptimumData(3,traindata)= Num(3);
     OptimumData;


end
```

APPENDIX B

RESULT OF DATA SEGMENTATION VARIABLES *a, b* AND *c*

Group	Original			Training			Validation			Testing		
Tr	1.1	81.4	28.7	1.1	81.4	28.7	1.4	74.1	74.8	2.5	34.2	71.7
Tr	1.2	79.8	75.8	1.2	79.8	75.8	2.1	51.8	49.0	4.7	27.0	23.1
Tr	1.3	51.6	55.9	1.3	51.6	55.9	2.2	53.3	26.9	6.0	67.6	5.6
Va	1.4	74.1	74.8	1.5	40.7	76.1	2.3	86.9	15.4	7.3	45.8	87.8
Tr	1.5	40.7	76.1	1.7	96.8	50.2	2.4	96.2	88.1	11.6	28.1	23.5
Tr	1.7	96.8	50.2	1.8	68.6	17.8	2.9	6.2	75.7	14.2	10.8	84.2
Tr	1.8	68.6	17.8	1.9	65.3	85.4	3.2	21.0	87.6	15.2	58.0	18.9
Tr	1.9	65.3	85.4	2.6	17.2	10.1	3.3	83.3	29.1	16.4	87.3	68.5
Va	2.1	51.8	49.0	2.7	41.8	96.0	3.4	5.1	33.0	17.1	52.5	53.5
Va	2.2	53.3	26.9	2.8	21.6	67.1	3.5	1.9	50.7	18.5	66.3	83.9
Va	2.3	86.9	15.4	3.0	81.9	66.8	3.7	48.1	10.6	21.5	1.4	61.5
Va	2.4	96.2	88.1	3.8	49.7	16.6	3.9	52.4	54.3	21.6	95.1	64.8
Te	2.5	34.2	71.7	4.4	33.6	18.4	4.3	80.5	56.1	22.4	94.9	87.9
Tr	2.6	17.2	10.1	4.6	29.3	4.6	4.4	33.6	18.4	23.2	30.4	74.9
Tr	2.7	41.8	96.0	4.8	16.1	22.3	5.0	93.9	90.6	23.6	55.4	68.4
Tr	2.8	21.6	67.1	5.3	60.7	87.0	5.1	79.7	75.2	27.1	1.8	32.7
Va	2.9	6.2	75.7	5.7	12.9	5.9	5.4	35.9	29.2	27.2	44.9	65.2
Tr	3.0	81.9	66.8	5.9	43.6	95.1	5.6	60.1	49.7	27.7	54.4	96.3
Va	3.2	21.0	87.6	6.1	34.4	37.9	6.2	31.9	61.3	28.1	9.8	63.9
Va	3.3	83.3	29.1	6.6	19.3	76.9	7.5	5.2	69.5	28.7	14.6	74.9
Va	3.4	5.1	33.0	6.7	99.1	95.0	7.9	45.8	81.4	30.6	33.9	67.7
Va	3.5	1.9	50.7	6.8	50.0	15.2	8.6	65.9	9.9	31.0	1.0	59.9
Va	3.7	48.1	10.6	7.0	4.6	92.2	8.9	56.5	14.3	31.5	37.1	83.6
Tr	3.8	49.7	16.6	7.1	46.9	91.1	9.4	13.0	65.8	31.7	17.4	55.0
Va	3.9	52.4	54.3	7.2	79.1	88.5	9.8	89.1	87.0	32.8	53.1	94.1
Va	4.3	80.5	56.1	7.4	3.9	16.8	9.9	58.3	18.3	35.5	90.6	90.5
Tr	4.4	33.6	18.4	7.7	15.1	24.4	10.1	32.7	33.4	37.1	67.2	15.4
Va	4.5	60.9	78.7	7.8	81.4	21.1	10.5	78.4	77.6	37.2	95.8	20.8
Tr	4.6	29.3	4.6	8.0	4.3	24.4	11.0	25.2	85.4	37.4	41.6	6.1
Te	4.7	27.0	23.1	8.2	66.1	20.9	11.2	37.7	7.2	38.8	85.8	57.3
Tr	4.8	16.1	22.3	8.3	57.4	31.2	11.5	49.9	52.6	40.9	74.9	76.8
Va	5.0	93.9	90.6	8.4	86.6	97.4	11.7	19.6	93.4	41.4	78.6	94.2
Va	5.1	79.7	75.2	8.5	68.6	33.6	12.2	69.1	87.7	42.8	89.6	14.4
Tr	5.3	60.7	87.0	8.7	56.1	78.3	12.3	9.7	8.4	43.0	16.5	85.7
Va	5.4	35.9	29.2	8.8	5.3	94.6	12.5	13.5	60.0	43.3	55.5	17.6
Va	5.6	60.1	49.7	9.0	13.6	51.7	12.8	52.8	14.2	43.5	96.6	90.1
Tr	5.7	12.9	5.9	9.3	86.0	40.9	12.9	78.0	47.0	44.6	65.1	82.9
Tr	5.9	43.6	95.1	10.7	77.0	20.8	13.0	86.7	17.7	46.2	60.6	49.3
Te	6.0	67.6	5.6	10.8	73.1	14.0	13.3	38.6	59.6	47.4	9.9	56.3
Tr	6.1	34.4	37.9	10.9	72.5	98.8	13.4	17.6	59.8	48.3	82.5	23.9
Va	6.2	31.9	61.3	11.3	57.2	39.7	13.8	50.4	7.9	51.1	26.5	18.8
Tr	6.6	19.3	76.9	11.4	49.8	81.0	14.5	49.2	32.2	52.2	26.2	72.0
Tr	6.7	99.1	95.0	11.8	9.2	24.7	14.8	75.4	10.7	52.7	70.1	19.8
Tr	6.8	50.0	15.2	12.0	49.0	49.5	15.0	24.5	74.4	52.9	23.5	20.9
Tr	7.0	4.6	92.2	12.1	5.3	40.5	15.6	3.9	58.2	54.0	54.0	60.1
Tr	7.1	46.9	91.1	12.6	56.7	94.3	15.7	6.8	14.7	54.6	97.1	62.1
Tr	7.2	79.1	88.5	12.7	31.4	57.3	15.8	97.3	87.6	55.3	65.7	31.3
Te	7.3	45.8	87.8	13.1	28.0	23.5	16.2	67.5	41.5	57.4	91.4	46.8
Tr	7.4	3.9	16.8	13.2	81.8	2.8	16.5	33.1	61.8	58.3	20.1	53.7
Va	7.5	5.2	69.5	13.5	45.3	69.1	16.6	58.6	15.9	58.7	36.9	57.0
Tr	7.7	15.1	24.4	14.3	59.1	26.2	17.5	21.3	88.4	59.1	14.3	32.4
Tr	7.8	81.4	21.1	14.4	31.0	63.0	17.8	33.2	56.8	59.8	75.2	54.8
Va	7.9	45.8	81.4	14.6	47.3	95.9	17.9	62.7	95.4	62.2	61.0	25.4

Group	Original			Training			Validation			Testing		
Tr	8.0	4.3	24.4	14.9	39.8	83.8	18.1	3.7	43.9	63.4	76.9	16.6
Tr	8.2	66.1	20.9	15.3	48.3	9.3	18.2	97.3	87.6	64.0	13.6	31.2
Tr	8.3	57.4	31.2	15.5	56.2	75.2	18.3	6.6	88.2	65.0	51.5	78.4
Tr	8.4	86.6	97.4	16.0	72.8	47.5	18.6	86.9	22.1	65.2	74.3	2.9
Tr	8.5	68.6	33.6	16.8	39.9	11.5	18.8	71.1	5.8	65.4	92.1	30.6
Va	8.6	65.9	9.9	17.0	98.1	45.5	19.0	68.8	60.8	65.5	94.0	83.3
Tr	8.7	56.1	78.3	17.4	22.7	18.7	19.1	51.7	72.3	65.7	84.2	51.2
Tr	8.8	5.3	94.6	17.5	21.3	88.4	19.2	51.6	44.7	66.4	51.5	83.7
Va	8.9	56.5	14.3	18.7	78.2	84.7	19.3	76.7	81.5	66.5	96.9	18.9
Tr	9.0	13.6	51.7	18.9	24.0	90.7	19.6	19.1	35.1	67.0	7.4	71.4
Tr	9.3	86.0	40.9	19.5	60.0	91.9	19.8	34.3	49.0	67.9	5.2	41.0
Va	9.4	13.0	65.8	19.7	67.2	82.0	20.0	39.6	25.2	68.4	6.9	86.4
Va	9.8	89.1	87.0	19.9	87.3	91.7	20.1	51.3	62.6	68.5	91.6	96.7
Va	9.9	58.3	18.3	20.3	41.9	43.1	20.2	47.0	8.6	68.6	93.7	67.8
Va	10.1	32.7	33.4	20.4	66.8	9.8	20.5	48.2	27.2	70.1	72.2	31.7
Va	10.5	78.4	77.6	20.8	88.5	13.5	20.7	6.9	80.2	71.1	34.3	20.7
Tr	10.7	77.0	20.8	21.0	85.6	71.1	20.9	54.1	88.8	71.9	11.9	59.9
Tr	10.8	73.1	14.0	21.1	76.0	63.7	21.2	74.8	53.3	72.7	90.2	61.7
Tr	10.9	72.5	98.8	21.4	6.5	89.5	21.7	51.8	45.8	73.5	48.7	77.4
Va	11.0	25.2	85.4	21.8	11.6	90.3	21.9	66.1	1.2	75.0	91.9	78.1
Va	11.2	37.7	7.2	22.0	39.7	62.0	22.3	65.5	49.2	75.7	2.7	35.5
Tr	11.3	57.2	39.7	22.1	74.8	98.6	22.5	87.3	30.8	75.9	59.4	16.7
Tr	11.4	49.8	81.0	22.2	3.6	94.5	22.7	95.0	44.3	76.1	22.2	7.4
Va	11.5	49.9	52.6	22.6	61.2	48.5	22.9	62.7	83.7	76.7	8.8	7.1
Te	11.6	28.1	23.5	22.8	33.5	26.0	24.1	29.1	75.0	77.0	60.1	53.9
Va	11.7	19.6	93.4	23.1	41.4	91.4	24.3	58.1	16.7	79.2	63.5	47.8
Tr	11.8	9.2	24.7	23.3	47.5	90.4	24.5	34.0	20.4	79.3	46.5	18.3
Tr	12.0	49.0	49.5	23.4	9.7	58.3	24.6	91.4	7.9	79.9	86.8	35.5
Tr	12.1	5.3	40.5	23.5	76.9	78.2	24.9	9.3	80.1	82.0	2.1	36.4
Va	12.2	69.1	87.7	23.7	44.4	94.2	25.0	93.3	73.7	82.4	52.2	74.2
Va	12.3	9.7	8.4	23.9	68.8	8.5	25.2	26.2	80.4	83.3	41.5	51.4
Va	12.5	13.5	60.0	24.2	36.5	93.8	25.7	54.8	66.1	84.8	24.3	22.4
Tr	12.6	56.7	94.3	24.8	97.3	28.7	25.8	75.3	61.5	85.4	30.6	2.6
Tr	12.7	31.4	57.3	25.6	31.8	92.5	25.9	94.7	7.4	85.8	97.8	49.1
Va	12.8	52.8	14.2	26.0	63.4	59.7	26.1	49.1	22.0	87.1	81.5	75.2
Va	12.9	78.0	47.0	26.8	31.9	63.4	26.7	81.5	56.6	88.1	55.8	38.9
Va	13.0	86.7	17.7	27.5	8.1	48.7	27.0	72.5	90.6	88.8	74.6	41.1
Tr	13.1	28.0	23.5	27.8	45.5	15.9	27.3	17.2	49.7	88.9	4.3	49.3
Tr	13.2	81.8	2.8	28.0	14.6	61.1	27.9	6.7	51.5	89.0	45.7	29.6
Va	13.3	38.6	59.6	28.4	58.9	72.1	28.2	24.0	39.4	91.9	22.8	97.1
Va	13.4	17.6	59.8	29.0	80.0	4.1	28.3	62.1	99.9	92.4	87.8	24.2
Tr	13.5	45.3	69.1	29.1	86.6	31.2	28.5	59.9	63.9	92.6	28.8	8.2
Va	13.8	50.4	7.9	29.8	36.8	12.4	28.6	24.7	39.6	92.7	63.5	56.9
Te	14.2	10.8	84.2	29.9	13.3	81.7	28.8	87.1	29.9	93.5	79.8	14.9
Tr	14.3	59.1	26.2	30.0	61.6	6.0	28.9	71.3	55.1	94.0	75.7	29.2
Tr	14.4	31.0	63.0	30.1	53.3	10.3	29.2	49.4	32.2	94.4	57.6	53.9
Va	14.5	49.2	32.2	30.2	29.8	41.0	29.4	55.9	21.8	94.6	80.4	61.9
Tr	14.6	47.3	95.9	30.5	14.6	17.3	29.5	39.8	25.2	94.7	88.3	30.5
Va	14.8	75.4	10.7	31.9	16.3	8.7	29.6	78.5	79.7	95.1	21.0	6.6
Tr	14.9	39.8	83.8	32.1	78.8	13.1	29.7	18.7	88.5	95.7	37.5	77.0
Va	15.0	24.5	74.4	32.3	82.3	17.6	30.3	74.0	74.2	96.2	3.9	14.8
Te	15.2	58.0	18.9	32.4	10.2	89.7	30.4	55.1	95.5	98.0	21.7	89.2
Tr	15.3	48.3	9.3	32.6	96.5	11.3	30.8	33.9	35.3	98.3	33.1	56.0

Group	Original			Training			Validation		
Tr	15.5	56.2	75.2	32.7	49.9	11.0	31.1	57.2	87.1
Va	15.6	3.9	58.2	33.0	96.7	46.9	31.2	67.3	71.9
Va	15.7	6.8	14.7	33.7	45.8	59.9	31.3	24.2	20.6
Va	15.8	97.3	87.6	33.9	48.2	89.1	31.6	38.3	8.7
Tr	16.0	72.8	47.5	34.0	85.5	74.7	31.8	18.6	62.0
Va	16.2	67.5	41.5	34.1	60.5	37.4	32.0	82.5	58.9
Te	16.4	87.3	68.5	34.4	40.5	99.2	32.2	76.7	42.0
Va	16.5	33.1	61.8	34.7	29.0	40.8	32.5	4.8	1.2
Va	16.6	58.6	15.9	35.1	1.7	29.5	33.1	48.5	9.4
Tr	16.8	39.9	11.5	35.3	70.9	72.0	33.2	91.6	64.6
Tr	17.0	98.1	45.5	35.4	39.6	83.1	33.3	55.6	28.3
Te	17.1	52.5	53.5	35.6	76.7	63.3	33.5	85.3	19.9
Tr	17.4	22.7	18.7	36.1	19.6	13.7	33.6	39.3	55.2
Tr	17.5	21.3	88.4	36.2	18.8	61.7	33.8	76.8	61.9
Va	17.7	64.3	26.5	36.5	31.7	83.2	34.2	23.7	96.9
Va	17.8	33.2	56.8	36.8	29.5	53.9	34.3	45.3	55.1
Va	17.9	62.7	95.4	36.9	7.6	40.8	34.5	73.6	77.7
Va	18.1	3.7	43.9	37.5	18.3	57.3	34.6	9.6	93.6
Va	18.2	97.3	87.6	37.9	29.4	78.2	34.8	13.9	32.6
Va	18.3	6.6	88.2	38.4	69.3	86.1	34.9	75.7	16.1
Te	18.5	66.3	83.9	38.7	44.7	93.2	35.8	49.7	10.7
Va	18.6	86.9	22.1	38.9	70.9	47.3	36.6	28.6	68.8
Tr	18.7	78.2	84.7	39.1	38.3	55.7	37.6	66.6	96.1
Va	18.8	71.1	5.8	39.2	19.7	33.2	37.7	41.4	55.7
Tr	18.9	24.0	90.7	39.3	15.4	96.2	37.8	99.8	72.4
Va	19.0	68.8	60.8	39.7	65.5	73.7	38.0	79.9	3.3
Va	19.1	51.7	72.3	40.1	15.6	56.1	38.1	66.3	11.7
Va	19.2	51.6	44.7	40.2	45.2	79.4	38.2	43.7	50.4
Va	19.3	76.7	81.5	40.4	84.6	66.9	38.3	89.7	94.2
Tr	19.5	60.0	91.9	40.6	34.0	39.9	38.5	8.4	64.1
Va	19.6	19.1	35.1	40.7	34.8	37.6	38.6	21.3	44.1
Tr	19.7	67.2	82.0	40.8	27.4	93.9	39.4	52.4	12.2
Va	19.8	34.3	49.0	41.0	83.0	36.1	39.5	42.6	75.5
Va	19.9	87.3	91.7	41.7	51.7	71.2	39.6	67.9	9.7
Va	20.0	39.6	25.2	42.0	57.3	97.3	39.9	55.1	28.8
Va	20.1	51.3	62.6	42.1	94.8	84.9	40.0	31.6	51.2
Va	20.2	47.0	8.6	42.2	86.9	52.4	40.3	94.0	97.5
Tr	20.3	41.9	43.1	42.7	31.5	69.3	41.1	50.4	47.8
Tr	20.4	66.8	9.8	43.2	23.7	55.5	41.5	23.6	57.6
Va	20.5	48.2	27.2	43.4	89.8	67.7	41.6	37.9	50.0
Va	20.7	6.9	80.2	43.9	22.9	16.9	41.8	33.6	83.0
Tr	20.8	88.5	13.5	44.4	79.3	72.3	41.9	42.4	11.1
Va	20.9	54.1	88.8	45.0	24.4	88.9	42.3	57.9	1.7
Tr	21.0	85.6	71.1	45.2	64.7	12.9	42.5	72.1	61.2
Tr	21.1	76.0	63.7	45.4	16.8	34.0	42.6	24.6	82.6
Va	21.2	74.8	53.3	45.8	65.4	28.5	43.1	3.5	68.2
Tr	21.4	6.5	89.5	46.0	66.2	14.0	43.6	75.5	93.1
Te	21.5	1.4	61.5	46.1	74.5	60.6	43.7	95.5	98.4
Te	21.6	95.1	64.8	46.3	7.7	74.2	43.8	66.0	10.4
Va	21.7	51.8	45.8	46.4	87.8	79.5	44.1	4.8	92.3
Tr	21.8	11.6	90.3	47.0	92.8	35.7	44.7	7.5	59.2
Va	21.9	66.1	1.2	47.1	52.5	18.5	44.9	95.2	59.3
Tr	22.0	39.7	62.0	47.2	27.1	56.7	45.3	18.6	64.7

Group	Original			Training			Validation		
Tr	22.1	74.8	98.6	47.3	63.9	57.6	45.7	7.1	8.2
Tr	22.2	3.6	94.5	47.6	22.1	53.6	45.9	44.4	83.8
Va	22.3	65.5	49.2	47.8	93.1	96.6	46.5	17.9	87.3
Te	22.4	94.9	87.9	48.0	56.1	12.6	46.7	28.3	41.8
Va	22.5	87.3	30.8	48.4	83.5	24.5	46.8	18.2	21.9
Tr	22.6	61.2	48.5	49.0	42.0	86.2	46.9	86.1	57.0
Va	22.7	95.0	44.3	49.4	93.1	91.5	47.5	39.4	41.5
Tr	22.8	33.5	26.0	49.6	37.8	78.2	47.7	15.0	50.8
Va	22.9	62.7	83.7	49.9	51.3	32.2	48.1	30.2	72.1
Tr	23.1	41.4	91.4	50.0	69.0	95.7	48.2	69.4	81.0
Te	23.2	30.4	74.9	50.2	95.2	94.9	48.5	54.6	50.1
Tr	23.3	47.5	90.4	50.4	55.9	42.5	48.6	96.7	13.2
Tr	23.4	9.7	58.3	50.5	8.2	71.0	48.7	19.1	64.0
Tr	23.5	76.9	78.2	51.0	24.5	78.3	49.1	62.2	52.4
Te	23.6	55.4	68.4	51.6	74.0	23.4	49.5	24.3	43.9
Tr	23.7	44.4	94.2	51.8	68.0	62.0	50.1	10.6	43.0
Tr	23.9	68.8	8.5	52.0	81.1	12.5	50.3	93.1	29.3
Va	24.1	29.1	75.0	52.1	37.1	11.1	50.6	51.9	53.2
Tr	24.2	36.5	93.8	53.0	8.4	21.6	50.8	45.6	63.1
Va	24.3	58.1	16.7	53.1	92.9	44.6	50.9	68.6	98.4
Va	24.5	34.0	20.4	53.2	32.4	92.5	51.2	39.8	71.6
Va	24.6	91.4	7.9	53.5	45.9	17.2	51.4	72.4	69.0
Tr	24.8	97.3	28.7	53.8	16.8	18.3	51.9	67.4	17.0
Va	24.9	9.3	80.1	53.9	82.2	68.0	52.3	41.0	53.2
Va	25.0	93.3	73.7	54.1	45.0	80.9	52.4	32.8	54.5
Va	25.2	26.2	80.4	54.3	84.8	3.0	52.5	62.5	58.0
Tr	25.6	31.8	92.5	54.7	41.8	2.9	52.8	48.8	85.6
Va	25.7	54.8	66.1	54.9	99.2	19.3	53.4	81.9	69.3
Va	25.8	75.3	61.5	55.1	44.8	82.7	54.2	9.1	85.7
Va	25.9	94.7	7.4	55.2	94.0	64.7	54.4	37.9	91.5
Tr	26.0	63.4	59.7	55.5	68.6	21.4	54.5	13.8	24.7
Va	26.1	49.1	22.0	55.6	4.6	40.4	54.8	99.6	43.8
Va	26.7	81.5	56.6	56.2	10.9	85.7	55.0	47.5	1.5
Tr	26.8	31.9	63.4	56.5	56.1	70.1	55.7	83.5	16.8
Va	27.0	72.5	90.6	57.1	55.2	96.0	55.9	18.1	30.2
Te	27.1	1.8	32.7	58.2	65.4	50.4	56.0	39.4	35.4
Te	27.2	44.9	65.2	58.4	20.3	26.3	56.3	20.5	21.6
Va	27.3	17.2	49.7	58.6	52.5	47.4	56.6	72.2	53.3
Tr	27.5	8.1	48.7	58.9	70.9	33.4	56.9	90.3	41.3
Te	27.7	54.4	96.3	59.2	66.2	46.6	57.2	96.9	43.3
Tr	27.8	45.5	15.9	59.3	5.0	37.3	57.5	90.1	48.2
Va	27.9	6.7	51.5	59.7	32.7	7.8	57.6	5.9	16.0
Tr	28.0	14.6	61.1	60.1	66.4	48.4	57.7	82.8	81.4
Te	28.1	9.8	63.9	60.3	56.7	89.0	57.8	78.5	61.4
Va	28.2	24.0	39.4	60.4	80.1	35.0	57.9	89.9	8.6
Va	28.3	62.1	99.9	60.8	81.6	9.7	58.0	89.5	51.6
Tr	28.4	58.9	72.1	60.9	83.4	40.3	58.1	99.4	56.4
Va	28.5	59.9	63.9	61.0	22.1	43.7	58.8	75.0	99.7
Va	28.6	24.7	39.6	61.3	46.7	88.9	59.0	97.5	81.0
Te	28.7	14.6	74.9	61.4	63.3	44.1	59.6	98.6	1.6
Va	28.8	87.1	29.9	61.5	49.0	30.2	59.9	45.1	57.2
Va	28.9	71.3	55.1	61.7	43.3	99.4	60.6	43.1	40.6
Tr	29.0	80.0	4.1	62.1	16.9	31.2	61.1	69.4	39.4
Tr	29.1	86.6	31.2	62.3	35.6	97.7	61.2	72.9	59.2

Group	Original			Training			Validation		
Va	29.2	49.4	32.2	62.6	83.6	10.9	61.8	20.1	81.1
Va	29.4	55.9	21.8	62.9	52.2	27.9	62.0	62.0	51.8
Va	29.5	39.8	25.2	63.0	34.6	23.3	62.5	91.5	82.3
Va	29.6	78.5	79.7	63.8	90.9	99.4	62.7	17.2	54.9
Va	29.7	18.7	88.5	64.1	66.9	94.8	62.8	53.0	15.4
Tr	29.8	36.8	12.4	64.4	65.3	40.3	63.2	49.1	60.7
Tr	29.9	13.3	81.7	64.5	45.9	79.6	63.3	34.8	97.0
Tr	30.0	61.6	6.0	64.8	73.9	55.1	63.6	23.0	11.7
Tr	30.1	53.3	10.3	65.1	37.0	37.5	63.7	73.4	25.1
Tr	30.2	29.8	41.0	65.3	51.2	92.3	63.9	70.2	95.8
Va	30.3	74.0	74.2	65.6	83.7	11.8	64.6	68.7	62.5
Va	30.4	55.1	95.5	65.8	31.8	96.6	64.7	11.5	40.0
Tr	30.5	14.6	17.3	66.2	63.9	30.9	65.9	97.0	29.5
Te	30.6	33.9	67.7	66.8	25.0	28.5	66.0	74.8	25.5
Va	30.8	33.9	35.3	67.5	62.8	81.0	66.1	78.8	10.8
Te	31.0	1.0	59.9	67.7	3.3	29.5	66.3	5.5	32.0
Va	31.1	57.2	87.1	68.0	60.5	66.6	66.7	77.9	56.1
Va	31.2	67.3	71.9	68.9	87.7	11.5	66.9	59.7	44.7
Va	31.3	24.2	20.6	69.1	40.3	32.2	67.2	7.5	80.5
Te	31.5	37.1	83.6	69.3	11.7	14.0	67.3	94.6	93.7
Va	31.6	38.3	8.7	69.8	70.8	1.9	67.4	50.4	22.5
Te	31.7	17.4	55.0	70.3	55.9	90.0	68.1	23.3	93.7
Va	31.8	18.6	62.0	70.4	8.2	15.9	68.2	39.2	40.7
Tr	31.9	16.3	8.7	70.7	46.2	26.2	68.3	16.8	90.2
Va	32.0	82.5	58.9	70.8	69.3	10.7	68.7	34.2	18.0
Tr	32.1	78.8	13.1	70.9	40.8	85.9	69.4	73.6	8.0
Va	32.2	76.7	42.0	71.0	53.0	19.5	69.5	20.0	28.4
Tr	32.3	82.3	17.6	71.2	7.8	16.5	69.6	35.9	74.8
Tr	32.4	10.2	89.7	71.3	28.2	3.4	69.9	53.2	98.5
Va	32.5	4.8	1.2	71.4	29.0	45.5	70.0	30.9	33.7
Tr	32.6	96.5	11.3	72.2	22.7	77.3	70.5	5.9	49.6
Tr	32.7	49.9	11.0	72.4	32.5	39.7	71.5	2.8	72.1
Te	32.8	53.1	94.1	72.8	97.3	11.0	71.8	54.8	29.3
Tr	33.0	96.7	46.9	73.1	11.7	65.9	72.0	29.6	38.1
Va	33.1	48.5	9.4	73.3	61.7	76.1	72.5	46.2	83.0
Va	33.2	91.6	64.6	73.4	36.2	10.3	72.6	50.9	91.8
Va	33.3	55.6	28.3	73.6	47.0	10.1	72.9	79.6	27.5
Va	33.5	85.3	19.9	73.9	31.9	62.0	73.0	91.3	74.4
Va	33.6	39.3	55.2	74.2	17.9	63.1	74.0	24.9	4.0
Tr	33.7	45.8	59.9	74.3	86.4	93.9	74.5	69.5	81.6
Va	33.8	76.8	61.9	74.9	39.8	12.4	74.7	63.4	20.3
Tr	33.9	48.2	89.1	75.1	25.4	18.9	74.8	13.8	83.1
Tr	34.0	85.5	74.7	75.3	93.5	53.2	75.2	40.3	98.1
Tr	34.1	60.5	37.4	75.4	38.5	91.2	75.5	88.6	10.8
Va	34.2	23.7	96.9	75.6	18.3	44.8	75.8	94.8	68.2
Va	34.3	45.3	55.1	76.0	12.7	45.5	76.5	84.6	73.3
Tr	34.4	40.5	99.2	76.2	6.0	94.8	76.6	69.1	49.3
Va	34.5	73.6	77.7	76.8	17.2	17.6	77.2	68.1	93.0
Va	34.6	9.6	93.6	76.9	74.5	48.8	78.1	72.5	72.3
Tr	34.7	29.0	40.8	77.1	5.7	17.7	78.2	17.9	6.8
Va	34.8	13.9	32.6	77.3	53.8	85.3	78.3	71.7	45.4
Va	34.9	75.7	16.1	77.5	48.1	35.4	78.4	27.8	97.9
Tr	35.1	1.7	29.5	77.6	60.2	83.5	78.7	46.3	43.4

Group	Original			Training			Validation		
Tr	35.3	70.9	72.0	77.8	43.4	5.7	78.8	4.3	25.5
Tr	35.4	39.6	83.1	78.0	67.8	76.4	79.0	62.5	42.2
Te	35.5	90.6	90.5	78.5	68.5	79.0	79.1	44.1	68.3
Tr	35.6	76.7	63.3	78.9	57.2	84.7	79.4	61.8	94.2
Va	35.8	49.7	10.7	79.6	23.1	64.2	79.5	72.0	7.6
Tr	36.1	19.6	13.7	80.1	65.3	86.3	80.4	38.3	73.8
Tr	36.2	18.8	61.7	80.3	25.8	81.9	80.6	76.1	72.5
Tr	36.5	31.7	83.2	80.6	76.1	72.5	81.0	15.0	64.0
Va	36.6	28.6	68.8	80.9	20.8	94.0	81.4	51.3	28.9
Tr	36.8	29.5	53.9	81.1	83.0	7.8	81.7	54.6	35.2
Tr	36.9	7.6	40.8	81.2	23.3	38.3	82.6	23.3	80.6
Te	37.1	67.2	15.4	81.8	7.3	31.6	82.8	62.2	88.7
Te	37.2	95.8	20.8	81.9	19.4	28.1	82.9	57.8	96.5
Te	37.4	41.6	6.1	82.2	89.8	75.5	83.1	79.9	24.9
Tr	37.5	18.3	57.3	82.3	63.7	15.6	83.2	75.4	45.9
Va	37.6	66.6	96.1	82.5	41.8	65.2	84.7	40.8	38.8
Va	37.7	41.4	55.7	82.7	82.1	37.4	84.9	72.7	76.0
Va	37.8	99.8	72.4	83.4	1.8	23.8	85.1	93.3	77.5
Tr	37.9	29.4	78.2	83.7	47.5	52.5	85.5	47.3	82.5
Va	38.0	79.9	3.3	83.9	79.6	82.4	85.7	37.0	16.5
Va	38.1	66.3	11.7	84.0	47.6	60.2	85.9	50.7	30.1
Va	38.2	43.7	50.4	84.1	99.7	31.3	86.2	36.3	95.0
Va	38.3	89.7	94.2	84.6	27.1	80.4	86.4	63.6	79.1
Tr	38.4	69.3	86.1	85.0	15.6	45.2	86.8	24.2	58.5
Va	38.5	8.4	64.1	85.2	100.0	61.9	86.9	47.4	50.3
Va	38.6	21.3	44.1	86.1	57.1	15.3	87.0	24.6	78.8
Tr	38.7	44.7	93.2	86.3	70.1	28.1	87.3	80.4	91.9
Te	38.8	85.8	57.3	86.5	40.1	25.4	87.7	51.2	20.8
Tr	38.9	70.9	47.3	87.2	51.0	84.9	87.9	6.2	4.9
Tr	39.1	38.3	55.7	87.4	47.7	25.2	88.0	93.4	59.6
Tr	39.2	19.7	33.2	87.6	25.8	38.6	88.3	54.2	57.5
Tr	39.3	15.4	96.2	87.8	13.6	30.0	88.5	61.8	97.9
Va	39.4	52.4	12.2	88.2	95.3	40.2	88.7	10.3	47.3
Va	39.5	42.6	75.5	88.4	33.3	97.3	89.4	89.0	18.6
Va	39.6	67.9	9.7	88.6	65.0	13.6	89.5	32.8	94.6
Tr	39.7	65.5	73.7	89.3	52.6	73.5	89.8	58.1	95.9
Va	39.9	55.1	28.8	90.0	14.4	58.9	89.9	43.8	8.5
Va	40.0	31.6	51.2	90.1	48.2	80.9	90.4	28.3	17.4
Tr	40.1	15.6	56.1	90.3	78.8	31.8	90.6	38.0	85.4
Tr	40.2	45.2	79.4	90.5	94.5	15.9	90.8	25.3	49.7
Va	40.3	94.0	97.5	91.0	93.3	28.1	90.9	51.4	52.5
Tr	40.4	84.6	66.9	91.4	56.4	98.5	91.3	48.9	26.3
Tr	40.6	34.0	39.9	91.6	83.6	45.1	91.8	21.3	1.6
Tr	40.7	34.8	37.6	92.5	62.8	29.1	92.0	77.0	5.5
Tr	40.8	27.4	93.9	92.9	19.1	32.2	92.1	53.6	77.2
Te	40.9	74.9	76.8	93.6	20.5	46.3	93.0	45.3	81.7
Tr	41.0	83.0	36.1	93.7	98.5	98.0	93.1	75.1	9.4
Va	41.1	50.4	47.8	93.9	84.8	58.9	93.3	6.3	67.0
Te	41.4	78.6	94.2	94.1	14.6	27.0	93.4	81.4	38.7
Va	41.5	23.6	57.6	94.2	45.0	40.4	93.8	91.2	82.2
Va	41.6	37.9	50.0	94.5	4.0	93.6	94.8	62.8	59.9
Tr	41.7	51.7	71.2	94.9	94.7	38.1	95.2	34.1	19.7
Va	41.8	33.6	83.0	95.0	77.2	66.8	95.4	69.2	17.3

Group	Original			Training			Validation		
Va	41.9	42.4	11.1	95.3	82.9	2.6	96.0	49.0	4.8
Tr	42.0	57.3	97.3	95.5	71.2	51.0	96.3	55.6	99.7
Tr	42.1	94.8	84.9	95.6	62.9	86.3	96.4	84.4	25.3
Tr	42.2	86.9	52.4	96.7	8.2	28.9	97.1	31.3	32.2
Va	42.3	57.9	1.7	96.8	95.8	51.8	97.3	40.3	66.3
Va	42.5	72.1	61.2	97.0	80.1	15.4	97.6	73.6	81.3
Va	42.6	24.6	82.6	97.2	34.2	68.5	97.7	21.6	52.9
Tr	42.7	31.5	69.3	97.5	49.5	65.3	97.8	99.1	56.5
Te	42.8	89.6	14.4	98.2	18.0	58.4	97.9	41.7	3.4
Te	43.0	16.5	85.7	98.5	30.2	95.4	98.1	49.7	51.5
Va	43.1	3.5	68.2	98.7	55.6	15.1	99.4	57.5	41.0
Tr	43.2	23.7	55.5	98.8	94.6	69.7	99.6	27.4	29.9
Te	43.3	55.5	17.6	99.1	44.5	48.6	99.7	6.0	94.9
Tr	43.4	89.8	67.7	99.3	13.1	11.4	99.8	76.2	24.8
Te	43.5	96.6	90.1						
Va	43.6	75.5	93.1						
Va	43.7	95.5	98.4						
Va	43.8	66.0	10.4						
Tr	43.9	22.9	16.9						
Va	44.1	4.8	92.3						
Tr	44.4	79.3	72.3						
Te	44.6	65.1	82.9						
Va	44.7	7.5	59.2						
Va	44.9	95.2	59.3						
Tr	45.0	24.4	88.9						
Tr	45.2	64.7	12.9						
Va	45.3	18.6	64.7						
Tr	45.4	16.8	34.0						
Va	45.7	7.1	8.2						
Tr	45.8	65.4	28.5						
Va	45.9	44.4	83.8						
Tr	46.0	66.2	14.0						
Tr	46.1	74.5	60.6						
Te	46.2	60.6	49.3						
Tr	46.3	7.7	74.2						
Tr	46.4	87.8	79.5						
Va	46.5	17.9	87.3						
Va	46.7	28.3	41.8						
Va	46.8	18.2	21.9						
Va	46.9	86.1	57.0						
Tr	47.0	92.8	35.7						
Tr	47.1	52.5	18.5						
Tr	47.2	27.1	56.7						
Tr	47.3	63.9	57.6						
Te	47.4	9.9	56.3						
Va	47.5	39.4	41.5						
Tr	47.6	22.1	53.6						
Va	47.7	15.0	50.8						
Tr	47.8	93.1	96.6						
Tr	48.0	56.1	12.6						
Va	48.1	30.2	72.1						
Va	48.2	69.4	81.0						
Te	48.3	82.5	23.9						

Group	Original		
Tr	48.4	83.5	24.5
Va	48.5	54.6	50.1
Va	48.6	96.7	13.2
Va	48.7	19.1	64.0
Tr	49.0	42.0	86.2
Va	49.1	62.2	52.4
Tr	49.4	93.1	91.5
Va	49.5	24.3	43.9
Tr	49.6	37.8	78.2
Tr	49.9	51.3	32.2
Tr	50.0	69.0	95.7
Va	50.1	10.6	43.0
Tr	50.2	95.2	94.9
Va	50.3	93.1	29.3
Tr	50.4	55.9	42.5
Tr	50.5	8.2	71.0
Va	50.6	51.9	53.2
Va	50.8	45.6	63.1
Va	50.9	68.6	98.4
Tr	51.0	24.5	78.3
Te	51.1	26.5	18.8
Va	51.2	39.8	71.6
Va	51.4	72.4	69.0
Tr	51.6	74.0	23.4
Tr	51.8	68.0	62.0
Va	51.9	67.4	17.0
Va	52.0	81.1	12.5
Tr	52.1	37.1	11.1
Te	52.2	26.2	72.0
Va	52.3	41.0	53.2
Va	52.4	32.8	54.5
Va	52.5	62.5	58.0
Te	52.7	70.1	19.8
Va	52.8	48.8	85.6
Te	52.9	23.5	20.9
Tr	53.0	8.4	21.6
Tr	53.1	92.9	44.6
Tr	53.2	32.4	92.5
Va	53.4	81.9	69.3
Tr	53.5	45.9	17.2
Tr	53.8	16.8	18.3
Tr	53.9	82.2	68.0
Te	54.0	54.0	60.1
Tr	54.1	45.0	80.9
Va	54.2	9.1	85.7
Tr	54.3	84.8	3.0
Va	54.4	37.9	91.5
Va	54.5	13.8	24.7
Te	54.6	97.1	62.1
Tr	54.7	41.8	2.9
Va	54.8	99.6	43.8
Tr	54.9	99.2	19.3
Va	55.0	47.5	1.5

Group	Original		
Tr	55.1	44.8	82.7
Tr	55.2	94.0	64.7
Te	55.3	65.7	31.3
Tr	55.5	68.6	21.4
Tr	55.6	4.6	40.4
Va	55.7	83.5	16.8
Va	55.9	18.1	30.2
Va	56.0	39.4	35.4
Tr	56.2	10.9	85.7
Va	56.3	20.5	21.6
Tr	56.5	56.1	70.1
Va	56.6	72.2	53.3
Va	56.9	90.3	41.3
Tr	57.1	55.2	96.0
Va	57.2	96.9	43.3
Te	57.4	91.4	46.8
Va	57.5	90.1	48.2
Va	57.6	5.9	16.0
Va	57.7	82.8	81.4
Va	57.8	78.5	61.4
Va	57.9	89.9	8.6
Va	58.0	89.5	51.6
Va	58.1	99.4	56.4
Tr	58.2	65.4	50.4
Te	58.3	20.1	53.7
Tr	58.4	20.3	26.3
Tr	58.6	52.5	47.4
Te	58.7	36.9	57.0
Va	58.8	75.0	99.7
Tr	58.9	70.9	33.4
Va	59.0	97.5	81.0
Te	59.1	14.3	32.4
Tr	59.2	66.2	46.6
Tr	59.3	5.0	37.3
Va	59.6	98.6	1.6
Tr	59.7	32.7	7.8
Te	59.8	75.2	54.8
Va	59.9	45.1	57.2
Tr	60.1	66.4	48.4
Tr	60.3	56.7	89.0
Tr	60.4	80.1	35.0
Va	60.6	43.1	40.6
Tr	60.8	81.6	9.7
Tr	60.9	83.4	40.3
Tr	61.0	22.1	43.7
Va	61.1	69.4	39.4
Va	61.2	72.9	59.2
Tr	61.3	46.7	88.9
Tr	61.4	63.3	44.1
Tr	61.5	49.0	30.2
Tr	61.7	43.3	99.4
Va	61.8	20.1	81.1
Va	62.0	62.0	51.8

Group	Original		
Tr	62.1	16.9	31.2
Te	62.2	61.0	25.4
Tr	62.3	35.6	97.7
Va	62.5	91.5	82.3
Tr	62.6	83.6	10.9
Va	62.7	17.2	54.9
Va	62.8	53.0	15.4
Tr	62.9	52.2	27.9
Tr	63.0	34.6	23.3
Va	63.2	49.1	60.7
Va	63.3	34.8	97.0
Te	63.4	76.9	16.6
Va	63.6	23.0	11.7
Va	63.7	73.4	25.1
Tr	63.8	90.9	99.4
Va	63.9	70.2	95.8
Te	64.0	13.6	31.2
Tr	64.1	66.9	94.8
Tr	64.4	65.3	40.3
Tr	64.5	45.9	79.6
Va	64.6	68.7	62.5
Va	64.7	11.5	40.0
Tr	64.8	73.9	55.1
Te	65.0	51.5	78.4
Tr	65.1	37.0	37.5
Te	65.2	74.3	2.9
Tr	65.3	51.2	92.3
Te	65.4	92.1	30.6
Te	65.5	94.0	83.3
Tr	65.6	83.7	11.8
Te	65.7	84.2	51.2
Tr	65.8	31.8	96.6
Va	65.9	97.0	29.5
Va	66.0	74.8	25.5
Va	66.1	78.8	10.8
Tr	66.2	63.9	30.9
Va	66.3	5.5	32.0
Te	66.4	51.5	83.7
Te	66.5	96.9	18.9
Va	66.7	77.9	56.1
Tr	66.8	25.0	28.5
Va	66.9	59.7	44.7
Te	67.0	7.4	71.4
Va	67.2	7.5	80.5
Va	67.3	94.6	93.7
Va	67.4	50.4	22.5
Tr	67.5	62.8	81.0
Tr	67.7	3.3	29.5
Te	67.9	5.2	41.0
Tr	68.0	60.5	66.6
Va	68.1	23.3	93.7
Va	68.2	39.2	40.7
Va	68.3	16.8	90.2

Group	Original		
Te	68.4	6.9	86.4
Te	68.5	91.6	96.7
Te	68.6	93.7	67.8
Va	68.7	34.2	18.0
Tr	68.9	87.7	11.5
Tr	69.1	40.3	32.2
Tr	69.3	11.7	14.0
Va	69.4	73.6	8.0
Va	69.5	20.0	28.4
Va	69.6	35.9	74.8
Tr	69.8	70.8	1.9
Va	69.9	53.2	98.5
Va	70.0	30.9	33.7
Te	70.1	72.2	31.7
Tr	70.3	55.9	90.0
Tr	70.4	8.2	15.9
Va	70.5	5.9	49.6
Tr	70.7	46.2	26.2
Tr	70.8	69.3	10.7
Tr	70.9	40.8	85.9
Tr	71.0	53.0	19.5
Te	71.1	34.3	20.7
Tr	71.2	7.8	16.5
Tr	71.3	28.2	3.4
Tr	71.4	29.0	45.5
Va	71.5	2.8	72.1
Va	71.8	54.8	29.3
Te	71.9	11.9	59.9
Va	72.0	29.6	38.1
Tr	72.2	22.7	77.3
Tr	72.4	32.5	39.7
Va	72.5	46.2	83.0
Va	72.6	50.9	91.8
Te	72.7	90.2	61.7
Tr	72.8	97.3	11.0
Va	72.9	79.6	27.5
Va	73.0	91.3	74.4
Tr	73.1	11.7	65.9
Tr	73.3	61.7	76.1
Tr	73.4	36.2	10.3
Te	73.5	48.7	77.4
Tr	73.6	47.0	10.1
Tr	73.9	31.9	62.0
Va	74.0	24.9	4.0
Tr	74.2	17.9	63.1
Tr	74.3	86.4	93.9
Va	74.5	69.5	81.6
Va	74.7	63.4	20.3
Va	74.8	13.8	83.1
Tr	74.9	39.8	12.4
Te	75.0	91.9	78.1
Tr	75.1	25.4	18.9
Va	75.2	40.3	98.1

Group	Original		
Tr	75.3	93.5	53.2
Tr	75.4	38.5	91.2
Va	75.5	88.6	10.8
Tr	75.6	18.3	44.8
Te	75.7	2.7	35.5
Va	75.8	94.8	68.2
Te	75.9	59.4	16.7
Tr	76.0	12.7	45.5
Te	76.1	22.2	7.4
Tr	76.2	6.0	94.8
Va	76.5	84.6	73.3
Va	76.6	69.1	49.3
Te	76.7	8.8	7.1
Tr	76.8	17.2	17.6
Tr	76.9	74.5	48.8
Te	77.0	60.1	53.9
Tr	77.1	5.7	17.7
Va	77.2	68.1	93.0
Tr	77.3	53.8	85.3
Tr	77.5	48.1	35.4
Tr	77.6	60.2	83.5
Tr	77.8	43.4	5.7
Tr	78.0	67.8	76.4
Va	78.1	72.5	72.3
Va	78.2	17.9	6.8
Va	78.3	71.7	45.4
Va	78.4	27.8	97.9
Tr	78.5	68.5	79.0
Va	78.7	46.3	43.4
Va	78.8	4.3	25.5
Tr	78.9	57.2	84.7
Va	79.0	62.5	42.2
Va	79.1	44.1	68.3
Te	79.2	63.5	47.8
Te	79.3	46.5	18.3
Va	79.4	61.8	94.2
Va	79.5	72.0	7.6
Tr	79.6	23.1	64.2
Te	79.9	86.8	35.5
Tr	80.1	65.3	86.3
Va	80.3	25.8	81.9
Va	80.4	38.3	73.8
Va	80.6	76.1	72.5
Va	80.8	1.9	31.7
Va	80.9	20.8	94.0
Va	81.0	15.0	64.0
Tr	81.1	83.0	7.8
Tr	81.2	23.3	38.3
Va	81.4	51.3	28.9
Va	81.7	54.6	35.2
Tr	81.8	7.3	31.6
Tr	81.9	19.4	28.1
Te	82.0	2.1	36.4
Tr	82.2	89.8	75.5

Group	Original		
Tr	82.3	63.7	15.6
Te	82.4	52.2	74.2
Tr	82.5	41.8	65.2
Va	82.6	23.3	80.6
Tr	82.7	82.1	37.4
Va	82.8	62.2	88.7
Va	82.9	57.8	96.5
Va	83.1	79.9	24.9
Va	83.2	75.4	45.9
Te	83.3	41.5	51.4
Tr	83.4	1.8	23.8
Tr	83.7	47.5	52.5
Tr	83.9	79.6	82.4
Tr	84.0	47.6	60.2
Tr	84.1	99.7	31.3
Tr	84.6	27.1	80.4
Va	84.7	40.8	38.8
Te	84.8	24.3	22.4
Va	84.9	72.7	76.0
Tr	85.0	15.6	45.2
Va	85.1	93.3	77.5
Tr	85.2	100.0	61.9
Te	85.4	30.6	2.6
Va	85.5	47.3	82.5
Va	85.7	37.0	16.5
Te	85.8	97.8	49.1
Va	85.9	50.7	30.1
Tr	86.1	57.1	15.3
Va	86.2	36.3	95.0
Tr	86.3	70.1	28.1
Va	86.4	63.6	79.1
Tr	86.5	40.1	25.4
Va	86.8	24.2	58.5
Va	86.9	47.4	50.3
Va	87.0	24.6	78.8
Te	87.1	81.5	75.2
Tr	87.2	51.0	84.9
Va	87.3	80.4	91.9
Tr	87.4	47.7	25.2
Tr	87.6	25.8	38.6
Va	87.7	51.2	20.8
Tr	87.8	13.6	30.0
Va	87.9	6.2	4.9
Va	88.0	93.4	59.6
Te	88.1	55.8	38.9
Tr	88.2	95.3	40.2
Va	88.3	54.2	57.5
Tr	88.4	33.3	97.3
Va	88.5	61.8	97.9
Tr	88.6	65.0	13.6
Va	88.7	10.3	47.3
Te	88.8	74.6	41.1
Te	88.9	4.3	49.3
Te	89.0	45.7	29.6

Group	Original		
Tr	89.3	52.6	73.5
Va	89.4	89.0	18.6
Va	89.5	32.8	94.6
Va	89.8	58.1	95.9
Va	89.9	43.8	8.5
Tr	90.0	14.4	58.9
Tr	90.1	48.2	80.9
Tr	90.3	78.8	31.8
Va	90.4	28.3	17.4
Tr	90.5	94.5	15.9
Va	90.6	38.0	85.4
Va	90.8	25.3	49.7
Va	90.9	51.4	52.5
Tr	91.0	93.3	28.1
Va	91.3	48.9	26.3
Tr	91.4	56.4	98.5
Tr	91.6	83.6	45.1
Va	91.8	21.3	1.6
Te	91.9	22.8	97.1
Va	92.0	77.0	5.5
Va	92.1	53.6	77.2
Te	92.4	87.8	24.2
Tr	92.5	62.8	29.1
Te	92.6	28.8	8.2
Te	92.7	63.5	56.9
Tr	92.9	19.1	32.2
Va	93.0	45.3	81.7
Va	93.1	75.1	9.4
Va	93.3	6.3	67.0
Va	93.4	81.4	38.7
Te	93.5	79.8	14.9
Tr	93.6	20.5	46.3
Tr	93.7	98.5	98.0
Va	93.8	91.2	82.2
Tr	93.9	84.8	58.9
Te	94.0	75.7	29.2
Tr	94.1	14.6	27.0
Tr	94.2	45.0	40.4
Te	94.4	57.6	53.9
Tr	94.5	4.0	93.6
Te	94.6	80.4	61.9
Te	94.7	88.3	30.5
Va	94.8	62.8	59.9
Tr	94.9	94.7	38.1
Tr	95.0	77.2	66.8
Te	95.1	21.0	6.6
Va	95.2	34.1	19.7
Tr	95.3	82.9	2.6
Va	95.4	69.2	17.3
Tr	95.5	71.2	51.0
Tr	95.6	62.9	86.3
Te	95.7	37.5	77.0
Va	96.0	49.0	4.8

Group	Original		
Te	96.2	3.9	14.8
Va	96.3	55.6	99.7
Va	96.4	84.4	25.3
Tr	96.7	8.2	28.9
Tr	96.8	95.8	51.8
Tr	97.0	80.1	15.4
Va	97.1	31.3	32.2
Tr	97.2	34.2	68.5
Va	97.3	40.3	66.3
Tr	97.5	49.5	65.3
Va	97.6	73.6	81.3
Va	97.7	21.6	52.9
Va	97.8	99.1	56.5
Va	97.9	41.7	3.4
Te	98.0	21.7	89.2
Va	98.1	49.7	51.5
Tr	98.2	18.0	58.4
Te	98.3	33.1	56.0
Tr	98.5	30.2	95.4
Tr	98.7	55.6	15.1
Tr	98.8	94.6	69.7
Tr	99.1	44.5	48.6
Tr	99.3	13.1	11.4
Va	99.4	57.5	41.0
Va	99.6	27.4	29.9
Va	99.7	6.0	94.9
Va	99.8	76.2	24.8

APPENDIX C

OUTPUT DATA OF NEURAL NETWORK (P, I AND D TARGET)

Training Set			Validation Set			Testing Set		
P_Target	I_Target	D_Target	P_Target	I_Target	D_Target	P_Target	I_Target	D_Target
3.5	51.0	12.5	3.5	21.0	73.2	3.5	21.0	32.1
3.5	21.0	78.9	3.5	51.0	12.1	3.5	21.0	6.0
3.5	21.0	50.6	3.5	51.0	8.6	6.5	51.0	2.2
3.5	21.0	38.8	3.5	51.0	6.3	3.5	21.0	43.9
3.5	21.0	38.8	3.5	51.0	15.0	3.5	21.0	4.0
1.0	1.0	38.8	3.5	27.0	13.2	3.5	21.0	6.5
3.5	21.0	64.1	3.5	21.0	15.4	3.5	21.0	6.5
4.0	51.0	4.7	1.0	1.0	15.4	3.5	21.0	7.5
3.5	21.0	39.5	3.5	51.0	7.7	3.5	21.0	8.5
3.5	21.0	17.9	3.5	27.0	10.1	3.5	21.0	9.5
3.5	21.0	18.9	4.5	51.0	4.3	3.5	21.0	4.8
1.0	1.0	18.9	3.5	51.0	9.2	3.5	21.0	5.8
3.5	21.0	18.9	3.5	21.0	10.2	3.5	21.0	6.8
5.5	51.0	2.3	3.5	21.0	5.7	3.5	21.0	27.8
3.5	21.0	14.7	3.5	51.0	10.7	3.5	21.0	27.8
3.5	21.0	15.7	3.5	21.0	11.7	3.5	21.0	3.0
4.5	51.0	2.6	3.5	51.0	5.9	3.5	21.0	4.0
3.5	21.0	41.4	3.5	27.0	7.9	3.5	21.0	5.0
3.5	51.0	6.2	3.5	21.0	29.9	3.5	21.0	5.0
3.5	21.0	13.8	3.5	51.0	7.7	3.5	21.0	7.4
3.5	21.0	14.8	3.5	21.0	8.7	3.5	21.0	31.9
1.0	1.0	14.8	1.0	1.0	8.7	3.5	21.0	3.6
3.5	27.0	9.4	3.5	21.0	8.7	3.5	21.0	34.8
3.5	21.0	45.0	3.5	51.0	6.6	3.5	21.0	13.3
3.5	21.0	45.0	1.0	41.0	7.6	3.5	21.0	14.3
3.5	21.0	4.1	3.5	21.0	7.6	3.5	21.0	14.3
3.5	21.0	13.4	3.5	21.0	8.6	3.5	21.0	14.3
1.0	1.0	13.4	3.5	21.0	9.6	3.5	21.0	14.3
3.5	51.0	4.3	3.5	21.0	21.3	3.5	21.0	14.3
3.5	21.0	4.3	1.0	1.0	21.3	3.5	21.0	14.3
3.5	21.0	5.3	3.5	21.0	21.3	3.5	21.0	14.3
1.0	1.0	5.3	3.5	21.0	11.5	3.5	21.0	14.3
3.5	21.0	5.3	3.5	21.0	12.5	3.5	21.0	14.3
1.0	1.0	5.3	3.5	21.0	8.8	3.5	21.0	8.4
3.5	27.0	8.8	3.5	21.0	6.9	3.5	21.0	8.4
3.5	21.0	6.9	3.5	21.0	6.9	1.0	19.0	8.4
3.5	21.0	6.9	3.5	21.0	6.9	3.5	21.0	8.4
3.5	21.0	6.9	3.5	21.0	6.9	3.5	21.0	8.4
3.5	21.0	6.9	3.5	21.0	6.9	3.5	21.0	5.1
1.0	1.0	6.9	3.5	21.0	13.1	3.5	21.0	5.1
3.5	21.0	7.9	1.0	1.0	13.1	3.5	21.0	25.9
1.0	19.0	7.9	3.5	21.0	13.1	3.5	21.0	23.2
3.5	21.0	4.7	1.0	1.0	13.1	3.5	21.0	23.2
1.0	1.0	4.7	3.5	21.0	21.0	3.5	21.0	22.7
3.5	21.0	4.8	3.5	21.0	5.1	3.5	21.0	22.7
1.0	1.0	4.8	3.5	21.0	3.5	3.5	21.0	22.7
3.5	21.0	5.8	1.0	1.0	3.5	3.5	21.0	22.7
3.5	21.0	6.8	1.0	1.0	3.5	3.5	21.0	22.7
1.0	1.0	0.1	1.0	1.0	3.5	3.5	21.0	17.0
1.0	1.0	0.1	1.0	-1.0	3.5	3.5	21.0	35.4
1.0	1.0	0.1	3.5	21.0	15.8	3.5	21.0	11.6
3.5	21.0	28.9	3.5	21.0	16.8	3.5	21.0	11.6
3.5	21.0	29.9	3.5	21.0	17.8	3.5	21.0	11.6
3.5	21.0	30.9	3.5	51.0	4.0	3.5	21.0	11.6
1.0	1.0	30.9	3.5	21.0	6.0	3.5	21.0	10.8

Training Set			Validation Set			Testing Set		
P_Target	I_Target	D_Target	P_Target	I_Target	D_Target	P_Target	I_Target	D_Target
3.5	21.0	30.9	3.5	51.0	5.4	3.5	21.0	10.8
1.0	1.0	30.9	3.5	21.0	5.4	1.0	1.0	0.1
3.5	21.0	2.4	3.5	21.0	5.4	1.0	1.0	0.1
3.5	21.0	4.4	3.5	21.0	6.4	1.0	1.0	0.1
3.5	21.0	3.0	3.5	21.0	7.4	1.0	1.0	0.1
3.5	21.0	15.8	3.5	21.0	8.4	1.0	1.0	0.1
3.5	21.0	15.8	3.5	21.0	9.4	1.0	1.0	0.1
3.5	21.0	19.4	3.5	21.0	17.1	3.5	21.0	3.8
3.5	21.0	20.4	3.5	21.0	17.1	3.5	21.0	2.7
3.5	21.0	20.4	3.5	21.0	17.1	3.5	21.0	3.6
3.5	21.0	20.4	3.5	21.0	17.1	1.0	19.0	3.6
3.5	21.0	20.4	3.5	21.0	17.1	3.5	21.0	3.6
1.0	1.0	20.4	3.5	21.0	17.1	3.5	21.0	4.6
1.0	1.0	20.4	3.5	21.0	5.6	3.5	21.0	33.8
3.5	21.0	20.4	3.5	21.0	6.6	3.5	21.0	6.1
3.5	21.0	20.4	3.5	21.0	7.6	1.0	19.0	6.1
3.5	21.0	5.4	3.5	21.0	8.6	3.5	21.0	47.2
3.5	21.0	5.9	1.0	1.0	0.1	3.5	21.0	47.2
3.5	21.0	6.9	1.0	1.0	0.1	5.5	51.0	1.5
3.5	21.0	6.9	1.0	1.0	0.1	3.5	21.0	2.5
3.5	51.0	4.9	1.0	1.0	0.1	3.5	21.0	22.0
3.5	21.0	5.9	1.0	1.0	0.1	3.5	21.0	8.0
3.5	21.0	2.9	3.5	21.0	26.3	3.5	21.0	8.0
3.5	21.0	5.4	1.0	1.0	26.3	3.5	21.0	8.0
3.5	21.0	5.1	3.5	21.0	26.3	3.5	21.0	8.0
3.5	21.0	5.0	1.0	1.0	26.3	3.5	21.0	8.0
1.0	19.0	5.0	3.5	21.0	4.8	3.5	21.0	2.2
1.0	41.0	5.0	3.5	21.0	5.8	3.5	21.0	50.8
3.5	21.0	5.0	3.5	21.0	22.8	3.5	21.0	40.3
3.5	21.0	33.8	3.5	21.0	22.8	3.5	21.0	23.4
1.0	1.0	33.8	3.5	21.0	22.8	3.5	21.0	30.6
3.5	21.0	28.7	1.0	1.0	22.8	3.5	21.0	30.6
3.5	21.0	28.7	3.5	21.0	22.8	3.5	21.0	30.6
3.5	21.0	4.2	3.5	21.0	22.8	3.5	21.0	31.6
3.5	21.0	4.2	3.5	21.0	22.8	3.5	21.0	31.6
3.5	21.0	4.2	3.5	21.0	13.6	3.5	21.0	2.3
3.5	21.0	7.4	4.0	51.0	3.5	3.5	21.0	45.1
1.0	19.0	7.4	3.5	21.0	22.3	3.5	21.0	17.2
1.0	1.0	0.2	3.5	21.0	22.3	3.5	21.0	17.2
1.0	1.0	0.2	3.5	21.0	22.3	3.5	21.0	28.6
1.0	1.0	0.2	3.5	21.0	23.1	3.5	21.0	29.6
3.5	21.0	6.8	1.0	1.0	23.1	3.5	21.0	29.6
3.5	21.0	6.8	3.5	21.0	23.1	3.5	21.0	29.6
3.5	21.0	6.8	3.5	21.0	23.1	3.5	21.0	30.6
3.5	21.0	7.8	3.5	21.0	23.1	3.5	21.0	30.6
3.5	21.0	13.4	3.5	21.0	23.1	3.5	21.0	30.6
3.5	21.0	15.8	3.5	21.0	23.1	3.5	21.0	20.8
3.5	21.0	15.8	3.5	21.0	9.5	3.5	21.0	35.4
3.5	21.0	15.8	3.5	21.0	9.5	3.5	21.0	2.1
3.5	21.0	5.2	1.0	19.0	9.5	3.5	21.0	16.3
3.5	21.0	5.2	3.5	21.0	10.5	3.5	21.0	31.4
3.5	21.0	5.2	3.5	21.0	10.5			
3.5	21.0	5.2	3.5	21.0	10.5			
3.5	21.0	6.2	3.5	21.0	11.5			
3.5	21.0	7.2	3.5	21.0	11.5			
3.5	21.0	8.2	3.5	21.0	14.3			

Training Set			Validation Set		
P Target	I Target	D Target	P Target	I Target	D Target
3.5	21.0	8.2	3.5	21.0	14.3
3.5	21.0	38.0	3.5	21.0	14.3
4.5	51.0	2.6	3.5	21.0	4.6
5.0	51.0	2.0	3.5	21.0	4.6
3.5	21.0	4.0	1.0	1.0	4.6
3.5	21.0	5.0	1.0	-1.0	4.6
3.5	21.0	6.0	1.0	15.0	4.6
3.5	21.0	19.0	1.0	17.0	4.6
3.5	21.0	14.7	1.0	17.0	4.6
3.5	21.0	28.9	3.5	21.0	18.5
3.5	21.0	27.6	3.5	21.0	18.5
3.5	21.0	3.9	3.5	21.0	18.5
3.5	21.0	14.4	3.5	21.0	4.9
3.5	21.0	26.5	3.5	21.0	11.0
3.5	21.0	26.5	3.5	21.0	11.0
3.5	21.0	27.5	3.5	21.0	11.0
3.5	21.0	27.5	3.5	21.0	26.0
3.5	21.0	27.5	3.5	21.0	26.0
3.5	21.0	17.9	3.5	21.0	26.0
3.5	21.0	7.8	3.5	21.0	26.0
3.5	21.0	7.8	1.0	1.0	0.1
3.5	21.0	10.1	5.5	51.0	1.1
3.5	21.0	10.1	1.0	1.0	1.1
3.5	21.0	10.1	1.0	1.0	1.1
3.5	21.0	11.1	3.5	21.0	4.3
3.5	21.0	12.1	3.5	21.0	19.1
3.5	21.0	23.5	3.5	21.0	19.1
3.5	21.0	23.5	3.5	21.0	20.1
3.5	21.0	23.5	3.5	21.0	20.1
3.5	21.0	24.5	3.5	21.0	20.1
3.5	21.0	24.5	3.5	21.0	30.0
3.5	21.0	24.5	3.5	21.0	30.0
3.5	21.0	29.2	3.5	21.0	30.0
3.5	21.0	21.2	3.5	21.0	20.9
3.5	21.0	21.2	3.5	21.0	21.9
3.5	21.0	22.2	3.5	21.0	31.0
3.5	21.0	22.2	3.5	21.0	31.0
3.5	21.0	20.0	1.0	1.0	0.1
3.5	21.0	20.0	1.0	1.0	0.1
3.5	21.0	14.5	3.5	21.0	20.7
3.5	21.0	14.5	4.5	51.0	2.9
3.5	21.0	14.5	3.5	21.0	3.9
3.5	21.0	14.5	3.5	21.0	4.9
3.5	21.0	4.0	3.5	21.0	4.9
1.0	19.0	4.0	4.0	51.0	3.5
3.5	21.0	4.0	3.5	21.0	3.9
3.5	21.0	5.0	3.0	19.0	3.9
3.5	21.0	24.9	3.5	21.0	14.1
3.5	21.0	24.9	3.5	21.0	5.7
3.5	21.0	19.4	1.0	17.0	5.7
3.5	21.0	19.4	3.5	21.0	9.1
3.5	21.0	19.4	3.5	21.0	26.8
3.5	21.0	19.4	3.5	21.0	17.0
3.5	21.0	39.9	3.5	21.0	17.0
3.5	21.0	39.9	3.5	21.0	18.0
3.5	21.0	35.7	3.5	21.0	9.9

Training Set			Validation Set		
P_Target	I_Target	D_Target	P_Target	I_Target	D_Target
3.5	21.0	35.7	3.5	21.0	27.7
3.5	21.0	35.7	3.5	21.0	27.7
3.5	21.0	35.7	3.5	21.0	27.7
3.5	21.0	35.7	1.0	1.0	27.7
3.5	21.0	4.2	3.5	21.0	14.9
3.5	21.0	20.8	3.5	21.0	14.9
3.5	21.0	20.8	3.5	21.0	22.4
3.5	21.0	20.8	3.5	21.0	5.4
3.5	21.0	20.8	3.5	21.0	5.4
3.5	21.0	20.8	1.0	19.0	5.4
3.5	21.0	4.3	1.0	19.0	5.4
1.0	-1.0	4.3	1.0	19.0	5.4
3.5	21.0	29.3	3.5	21.0	38.0
3.5	21.0	29.3	3.5	21.0	38.0
3.5	21.0	15.7	3.5	21.0	38.0
3.5	21.0	15.7	3.5	21.0	38.0
3.5	21.0	16.7	3.5	21.0	31.1
1.0	1.0	0.1	3.5	21.0	31.1
3.5	21.0	1.1	3.5	21.0	32.1
4.0	47.0	1.1	3.5	21.0	32.1
3.5	21.0	43.0	3.5	21.0	4.7
3.5	21.0	43.0	3.5	21.0	35.4
3.5	21.0	43.0	3.5	21.0	11.8
3.5	21.0	2.4	3.5	21.0	11.8
3.5	21.0	5.6	1.0	1.0	0.1
3.5	21.0	5.6	1.0	1.0	0.1
1.0	19.0	5.6	3.5	21.0	16.3
3.5	21.0	5.6	3.5	21.0	17.3
3.5	21.0	19.0	3.5	21.0	19.5
3.5	21.0	19.0	3.5	21.0	19.5
3.5	21.0	19.0	3.5	21.0	19.5
3.5	21.0	19.0	3.5	21.0	19.5
3.5	21.0	2.6	3.5	21.0	19.5
3.5	21.0	32.6	3.5	21.0	3.1
3.5	21.0	32.6	1.0	1.0	3.1
3.5	21.0	32.6	1.0	17.0	3.1
3.5	21.0	32.6	3.5	21.0	3.1
3.5	21.0	32.6	1.0	17.0	3.1
3.5	21.0	32.6	1.0	17.0	3.1
3.5	21.0	20.0	1.0	1.0	3.1
3.5	21.0	44.8	1.0	1.0	3.1
3.5	21.0	44.8	1.0	1.0	0.1
5.0	45.0	1.7	1.0	1.0	0.1
3.5	21.0	41.0	1.0	1.0	0.1
3.5	21.0	14.9	1.0	1.0	0.1
3.5	21.0	32.7	1.0	1.0	0.1
3.5	21.0	32.7	3.5	21.0	14.6
3.5	21.0	32.7	3.5	21.0	14.6
3.5	21.0	34.0	3.5	21.0	14.6
3.5	21.0	34.0	3.5	21.0	13.1
3.5	21.0	34.0	3.5	21.0	13.1
3.5	21.0	34.0	3.5	21.0	13.1
3.5	21.0	44.2	3.5	21.0	31.8
3.5	21.0	44.2	3.5	21.0	22.6
3.5	21.0	36.1	3.5	21.0	22.6
3.5	21.0	37.1	3.5	21.0	22.6

Training Set			Validation Set		
P_Target	I_Target	D_Target	P_Target	I_Target	D_Target
3.5	21.0	37.1	3.5	21.0	22.6
3.5	21.0	28.5	3.5	21.0	5.9
3.5	21.0	28.5	3.5	21.0	5.9
3.5	21.0	23.9	3.5	21.0	5.9
3.5	21.0	23.9	3.5	21.0	5.9
3.5	21.0	1.8	3.5	21.0	2.9
1.0	1.0	1.8	1.0	19.0	2.9
3.5	21.0	2.8	1.0	19.0	2.9
3.5	21.0	39.6	3.5	21.0	3.9
3.5	21.0	10.4	1.0	19.0	3.9
1.0	1.0	0.1	3.5	21.0	4.9
1.0	1.0	0.1	3.5	21.0	18.2
3.5	21.0	5.2	3.5	21.0	38.2
1.0	19.0	5.2	3.5	21.0	8.5
3.5	21.0	5.2	3.5	21.0	33.8
3.5	21.0	38.7	3.5	21.0	33.8
3.5	21.0	38.7	3.5	21.0	18.6
3.5	21.0	4.0	3.5	21.0	33.8
3.5	21.0	28.2	3.5	21.0	34.8
3.5	21.0	27.4	3.5	21.0	29.9
3.5	21.0	18.6	3.5	21.0	3.1
3.5	21.0	31.3	4.5	51.0	2.5
3.5	21.0	31.3	5.0	33.0	1.6
3.5	21.0	6.0	3.5	21.0	28.4
1.0	19.0	6.0	3.5	21.0	44.4
3.5	21.0	36.0	3.5	21.0	49.1
3.5	21.0	36.0	3.5	21.0	49.1
3.5	21.0	29.9	3.5	21.0	49.1
3.5	21.0	13.2	3.5	21.0	24.8
3.5	21.0	13.2	3.5	21.0	24.8
3.5	21.0	39.6	3.5	21.0	24.8
3.5	21.0	24.7	3.5	21.0	7.0
3.5	21.0	24.7	3.5	21.0	37.8
3.5	21.0	36.1	3.5	21.0	37.8
3.5	21.0	15.5	3.5	21.0	37.8
3.5	21.0	6.5	3.5	21.0	37.8
3.5	21.0	3.1	3.5	21.0	37.8
3.5	21.0	16.2	3.5	21.0	37.8
3.5	21.0	16.2	3.5	21.0	37.8
3.5	21.0	3.0	3.5	21.0	17.6
1.0	17.0	3.0	3.5	21.0	17.6
1.0	19.0	3.0	3.5	21.0	23.8
1.0	17.0	3.0	3.5	21.0	45.4
3.5	21.0	3.0	3.5	21.0	2.3
1.0	17.0	3.0	1.0	19.0	2.3
1.0	17.0	3.0	3.5	21.0	42.6
1.0	17.0	3.0	3.5	21.0	42.6
3.5	21.0	20.0	3.5	21.0	1.2
3.5	21.0	21.0	3.5	21.0	36.4
3.5	21.0	22.2	3.5	21.0	36.4
3.5	21.0	22.2	3.5	21.0	7.6
3.5	21.0	14.3	3.5	21.0	7.6
3.5	21.0	14.3	3.5	21.0	7.6
3.5	21.0	21.6	3.5	21.0	19.2
3.5	21.0	3.8	3.5	21.0	20.2
3.5	21.0	17.9	3.5	21.0	56.2

Training Set			Validation Set		
P Target	L Target	D Target	P Target	L Target	D Target
3.5	21.0	17.9	3.5	21.0	56.2
3.5	21.0	17.9	3.5	21.0	56.2
3.5	21.0	40.3	3.5	21.0	39.9
3.5	21.0	40.3	3.5	21.0	39.9
5.5	51.0	1.0	3.5	21.0	39.9
3.5	21.0	46.5	3.5	21.0	45.6
3.5	21.0	46.5	3.5	21.0	36.6
3.5	21.0	46.4	3.5	21.0	37.6
3.5	21.0	46.4	3.5	21.0	33.6
3.5	21.0	23.8	3.5	21.0	34.6
3.5	21.0	11.9	3.5	21.0	21.6
3.5	21.0	11.9	3.5	21.0	46.4
3.5	21.0	11.9	3.5	21.0	20.9
3.5	21.0	11.9	3.5	21.0	21.9
3.5	21.0	39.6	3.5	21.0	22.9
3.5	21.0	49.4	3.5	21.0	5.4
3.5	21.0	47.3	1.0	19.0	5.4
3.5	21.0	24.3	3.5	21.0	53.2
3.5	21.0	10.9	3.5	21.0	54.2
3.5	21.0	10.9	3.5	21.0	5.3
3.5	21.0	30.2	3.5	21.0	5.3
3.5	21.0	30.2	3.5	21.0	29.7
3.5	21.0	51.3	3.5	21.0	56.5
3.5	21.0	7.3	3.5	21.0	43.7
3.5	21.0	46.6	3.5	21.0	27.8
3.5	21.0	46.6	3.5	21.0	35.7
3.5	21.0	46.6	3.5	21.0	23.3
3.5	21.0	46.6	3.5	21.0	50.5
3.5	21.0	54.7	3.5	21.0	48.5
3.5	21.0	54.7	3.5	21.0	21.3
3.5	21.0	1.6	1.0	15.0	21.3
3.5	21.0	17.3	3.5	21.0	52.2
3.5	21.0	18.0	3.5	21.0	43.5
3.5	21.0	18.0	3.5	21.0	43.5
3.5	21.0	18.0	3.5	21.0	3.3
3.5	21.0	12.5	3.5	21.0	3.3
3.5	21.0	44.2	1.0	19.0	3.3
5.0	51.0	2.1	3.5	21.0	3.3
3.5	21.0	3.1	3.5	21.0	33.6
3.5	21.0	4.1	3.5	21.0	33.6
1.0	1.0	0.1	3.0	21.0	49.0
1.0	1.0	0.1	3.5	21.0	53.8
1.0	1.0	0.1	3.5	21.0	53.8
3.5	21.0	4.2	3.5	21.0	30.3
1.0	19.0	4.2	3.5	21.0	38.7
3.5	21.0	4.2	3.5	21.0	38.7
3.5	21.0	32.2	3.5	21.0	18.9
3.5	21.0	48.2	3.5	21.0	18.9
3.5	21.0	13.9	3.0	21.0	41.7
3.5	21.0	26.7	3.5	21.0	48.7
3.5	21.0	27.7	3.5	21.0	49.7
3.5	21.0	27.7	3.5	21.0	26.4
3.5	21.0	43.5	3.5	21.0	3.1
3.5	21.0	12.3	3.5	21.0	4.1

APPENDIX D

RESULT OF ANOVA TEST

Anova: Single Factor_variable *a*

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	772	38947.1	50.449611	794.7127
Column 2	333	16455.2	49.415015	811.50815
Column 3	333	16362.2	49.135736	792.3726
Column 4	106	6129.2	57.822642	700.49243

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	6693.614	3	2231.2047	2.8192959	0.0377848	2.6106832
Within Groups	1218763.6	1540	791.40494			
Total	1225457.2	1543				

Anova: Single Factor_variable *b*

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	772	39177.3	50.747798	762.81435
Column 2	333	16630.6	49.941742	744.05521
Column 3	333	17103.7	51.362462	733.45404
Column 4	106	5446.9	51.385849	917.54846

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	385.31424	3	128.43808	0.1683351	0.9177726	2.6106832
Within Groups	1175005.5	1540	762.9906			
Total	1175390.8	1543				

Anova: Single Factor_variable *c*

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	772	39743.6	51.481347	830.68442
Column 2	333	17238	51.765766	884.0219
Column 3	333	17237.7	51.764865	813.35271
Column 4	106	5310.3	50.09717	741.09952

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	255.63101	3	85.210336	0.1023746	0.9586701	2.6106832
Within Groups	1281801.5	1540	832.33864			
Total	1282057.1	1543				

APPENDIX E

RESULT OF NORMAL DISTRIBUTION TEST

Table of Statistical Description of Data

INPUT PROPERTIES

Input Properties 1	
Mean	126.4105731
Standard Error	0.736837523
Median	129.1822
Mode	#N/A
Standard Deviation	20.47294804
Sample Variance	419.1416013
Kurtosis	1.438649806
Skewness	-0.783224108
Range	139.706
Minimum	47.6382
Maximum	187.3442
Sum	97588.9624
Count	772
Confidence Level(95.0%)	1.446444677

Input Properties 2	
Mean	103.7132957
Standard Error	0.740085731
Median	106.1845
Mode	#N/A
Standard Deviation	20.56319914
Sample Variance	422.8451587
Kurtosis	1.576349692
Skewness	-0.77241329
Range	141.3869
Minimum	22.4365
Maximum	163.8234
Sum	80066.6643
Count	772
Confidence Level(95.0%)	1.452821053

Input Properties 3	
Mean	73.8963775
Standard Error	0.83160695
Median	75.54255
Mode	67.74
Standard Deviation	23.1061059
Sample Variance	533.892131
Kurtosis	1.15851763
Skewness	-0.5250394
Range	156.0069
Minimum	-15.9564
Maximum	140.0505
Sum	57048.0034
Count	772
Confidence Level(95.0%)	1.63248126

Input Properties 4	
Mean	64.7624834
Standard Error	0.82027521
Median	65.5194
Mode	#N/A
Standard Deviation	22.7912548
Sample Variance	519.441297
Kurtosis	0.94772336
Skewness	-0.48763313
Range	145.5476
Minimum	-16.9545
Maximum	128.5931
Sum	49996.6372
Count	772
Confidence Level(95.0%)	1.61023655

Input Properties 5	
Mean	63.74837124
Standard Error	0.808213951
Median	64.63395
Mode	#N/A
Standard Deviation	22.4561341
Sample Variance	504.2779586
Kurtosis	1.128944138
Skewness	-0.585938366
Range	145.4804
Minimum	-21.6933
Maximum	123.7871
Sum	49213.7426
Count	772
Confidence Level(95.0%)	1.586559765

Input Properties 6	
Mean	63.74837124
Standard Error	0.808213951
Median	64.63395
Mode	#N/A
Standard Deviation	22.4561341
Sample Variance	504.2779586
Kurtosis	1.128944138
Skewness	-0.58593837
Range	145.4804
Minimum	-21.6933
Maximum	123.7871
Sum	49213.7426
Count	772
Confidence Level(95.0%)	1.586559765

Input Properties 7	
Mean	49.838438
Standard Error	0.80747034
Median	51.05925
Mode	#N/A
Standard Deviation	22.435473
Sample Variance	503.350447
Kurtosis	0.97786944
Skewness	-0.55224793
Range	145.6224
Minimum	-31.1485
Maximum	114.4739
Sum	38475.2741
Count	772
Confidence Level(95.0%)	1.58510002

Input Properties 8	
Mean	44.7862276
Standard Error	0.82194237
Median	45.41235
Mode	65.3501
Standard Deviation	22.8375768
Sample Variance	521.554914
Kurtosis	0.93766786
Skewness	-0.51932888
Range	149.5747
Minimum	-37.9801
Maximum	111.5946
Sum	34574.9677
Count	772
Confidence Level(95.0%)	1.61350927

Input Properties 9	
Mean	22.68165259
Standard Error	1.540738561
Median	30.33675
Mode	#N/A
Standard Deviation	42.80924833
Sample Variance	1832.631742
Kurtosis	2.164993547
Skewness	-1.258300096
Range	262.7364
Minimum	-154.3192
Maximum	108.4172
Sum	17510.2358
Count	772
Confidence Level(95.0%)	3.024538003

Input Properties 10	
Mean	39.3207158
Standard Error	0.827738063
Median	40.36295
Mode	36.2755
Standard Deviation	22.99860936
Sample Variance	528.9360324
Kurtosis	0.820792014
Skewness	-0.44971792
Range	147.5666
Minimum	-41.021
Maximum	106.5456
Sum	30355.5926
Count	772
Confidence Level(95.0%)	1.624886461

Input Properties 11	
Mean	31.9124574
Standard Error	0.89856806
Median	32.1042
Mode	#N/A
Standard Deviation	24.9666129
Sample Variance	623.331758
Kurtosis	0.42328042
Skewness	-0.28001635
Range	157.337
Minimum	-52.8676
Maximum	104.4694
Sum	24636.4171
Count	772
Confidence Level(95.0%)	1.76392888

Input Properties 12	
Mean	27.7318767
Standard Error	0.97351906
Median	27.0417
Mode	#N/A
Standard Deviation	27.0491181
Sample Variance	731.654791
Kurtosis	0.03067169
Skewness	-0.24176168
Range	159.2765
Minimum	-56.7554
Maximum	102.5211
Sum	21409.0088
Count	772
Confidence Level(95.0%)	1.91106102

Input Properties 13	
Mean	31.06146218
Standard Error	0.872931555
Median	31.5383
Mode	#N/A
Standard Deviation	24.25430546
Sample Variance	588.2713333
Kurtosis	0.530380565
Skewness	-0.34321496
Range	151.2706
Minimum	-50.0801
Maximum	101.1905
Sum	23979.4488
Count	772
Confidence Level(95.0%)	1.713603286

Input Properties 14	
Mean	21.8253522
Standard Error	1.039342385
Median	21.55125
Mode	#N/A
Standard Deviation	28.87801173
Sample Variance	833.9395615
Kurtosis	-0.15551592
Skewness	-0.21745261
Range	165.4424
Minimum	-65.8147
Maximum	99.6277
Sum	16849.1719
Count	772
Confidence Level(95.0%)	2.040275112

Input Properties 15	
Mean	24.6993659
Standard Error	0.95129279
Median	24.0896
Mode	#N/A
Standard Deviation	26.4315636
Sample Variance	698.627556
Kurtosis	0.15726891
Skewness	-0.2725892
Range	157.3811
Minimum	-59.0385
Maximum	98.3426
Sum	19067.9105
Count	772
Confidence Level(95.0%)	1.86742986

Input Properties 16	
Mean	23.9415484
Standard Error	0.94267047
Median	23.13225
Mode	#N/A
Standard Deviation	26.1919935
Sample Variance	686.020522
Kurtosis	0.20833948
Skewness	-0.28492574
Range	155.8556
Minimum	-58.5471
Maximum	97.3085
Sum	18482.8754
Count	772
Confidence Level(95.0%)	1.85050387

Input Properties 17	
Mean	9.974187306
Standard Error	1.561721287
Median	18.11715
Mode	#N/A
Standard Deviation	43.392251
Sample Variance	1882.887447
Kurtosis	2.143172697
Skewness	-1.265495045
Range	268.6179
Minimum	-172.4791
Maximum	96.1388
Sum	7700.0726
Count	772
Confidence Level(95.0%)	3.065728022

Input Properties 18	
Mean	21.14429676
Standard Error	0.969760351
Median	20.8667
Mode	#N/A
Standard Deviation	26.94468273
Sample Variance	726.0159272
Kurtosis	0.131853025
Skewness	-0.29100708
Range	165.774
Minimum	-70.5206
Maximum	95.2534
Sum	16323.3971
Count	772
Confidence Level(95.0%)	1.9036825

Input Properties 19	
Mean	17.635813
Standard Error	1.03726897
Median	17.7154
Mode	0.2937
Standard Deviation	28.8204022
Sample Variance	830.615583
Kurtosis	-0.00219574
Skewness	-0.3035154
Range	170.0352
Minimum	-75.6087
Maximum	94.4265
Sum	13614.8476
Count	772
Confidence Level(95.0%)	2.03620491

Input Properties 20	
Mean	13.6932994
Standard Error	1.14246684
Median	16.21395
Mode	#N/A
Standard Deviation	31.7433132
Sample Variance	1007.63793
Kurtosis	-0.3596321
Skewness	-0.32159289
Range	176.1155
Minimum	-82.5381
Maximum	93.5774
Sum	10571.2271
Count	772
Confidence Level(95.0%)	2.24271299

Input Properties 21	
Mean	17.45157565
Standard Error	1.013142637
Median	17.68435
Mode	#N/A
Standard Deviation	28.15005469
Sample Variance	792.425579
Kurtosis	0.032882487
Skewness	-0.311940626
Range	171.1893
Minimum	-78.2409
Maximum	92.9484
Sum	13472.6164
Count	772
Confidence Level(95.0%)	1.988843849

Input Properties 22	
Mean	11.57517681
Standard Error	1.188324229
Median	14.5726
Mode	#N/A
Standard Deviation	33.01745557
Sample Variance	1090.152372
Kurtosis	-0.11851869
Skewness	-0.44254997
Range	203.4367
Minimum	-111.1359
Maximum	92.3008
Sum	8936.0365
Count	772
Confidence Level(95.0%)	2.332733067

Input Properties 23	
Mean	13.0725819
Standard Error	1.10414737
Median	15.07175
Mode	-11.9876
Standard Deviation	30.6786109
Sample Variance	941.177169
Kurtosis	-0.29013244
Skewness	-0.30839075
Range	170.8475
Minimum	-79.1333
Maximum	91.7142
Sum	10092.0332
Count	772
Confidence Level(95.0%)	2.16749016

Input Properties 24	
Mean	13.6756443
Standard Error	1.082413
Median	15.1584
Mode	#N/A
Standard Deviation	30.0747238
Sample Variance	904.489014
Kurtosis	-0.09279649
Skewness	-0.35609637
Range	179.8385
Minimum	-88.5748
Maximum	91.2637
Sum	10557.5974
Count	772
Confidence Level(95.0%)	2.12482463

Input Properties 25	
Mean	4.467225777
Standard Error	1.57186867
Median	12.7795
Mode	#N/A
Standard Deviation	43.67419491
Sample Variance	1907.435301
Kurtosis	2.180556233
Skewness	-1.277403344
Range	272.5417
Minimum	-181.7507
Maximum	90.791
Sum	3448.6983
Count	772
Confidence Level(95.0%)	3.085647785

Input Properties 26	
Mean	11.73157707
Standard Error	1.118856057
Median	14.03435
Mode	51.0126
Standard Deviation	31.0872902
Sample Variance	966.4196121
Kurtosis	-0.26193263
Skewness	-0.3514956
Range	173.2083
Minimum	-82.7927
Maximum	90.4156
Sum	9056.7775
Count	772
Confidence Level(95.0%)	2.19636397

Input Properties 27	
Mean	9.70599197
Standard Error	1.19560317
Median	12.90785
Mode	44.3122
Standard Deviation	33.2197002
Sample Variance	1103.54848
Kurtosis	-0.07654849
Skewness	-0.48801108
Range	202.2623
Minimum	-112.1545
Maximum	90.1078
Sum	7493.0258
Count	772
Confidence Level(95.0%)	2.34702196

Input Properties 28	
Mean	6.90067811
Standard Error	1.29333854
Median	11.964
Mode	#N/A
Standard Deviation	35.9352665
Sample Variance	1291.34338
Kurtosis	-0.25140545
Skewness	-0.53705829
Range	197.6274
Minimum	-107.8177
Maximum	89.8097
Sum	5327.3235
Count	772
Confidence Level(95.0%)	2.53888081

Input Properties 29	
Mean	9.890491839
Standard Error	1.174350327
Median	13.204
Mode	#N/A
Standard Deviation	32.62919228
Sample Variance	1064.664189
Kurtosis	-0.221237601
Skewness	-0.444095557
Range	181.4498
Minimum	-91.8464
Maximum	89.6034
Sum	7635.4597
Count	772
Confidence Level(95.0%)	2.305301679

Input Properties 30	
Mean	6.048945984
Standard Error	1.336724971
Median	11.65915
Mode	#N/A
Standard Deviation	37.14075358
Sample Variance	1379.435576
Kurtosis	-0.02312298
Skewness	-0.65419528
Range	200.1775
Minimum	-110.7467
Maximum	89.4308
Sum	4669.7863
Count	772
Confidence Level(95.0%)	2.624050294

Input Properties 31	
Mean	7.23250764
Standard Error	1.2711922
Median	12.0467
Mode	#N/A
Standard Deviation	35.3199328
Sample Variance	1247.49765
Kurtosis	-0.19751667
Skewness	-0.54661804
Range	192.687
Minimum	-103.3849
Maximum	89.3021
Sum	5583.4959
Count	772
Confidence Level(95.0%)	2.49540656

Input Properties 32	
Mean	7.61935777
Standard Error	1.27752808
Median	12.52565
Mode	#N/A
Standard Deviation	35.4959745
Sample Variance	1259.9642
Kurtosis	-0.01357315
Skewness	-0.62469861
Range	192.4762
Minimum	-103.2396
Maximum	89.2366
Sum	5882.1442
Count	772
Confidence Level(95.0%)	2.50784417

Input Properties 33	
Mean	2.813337694
Standard Error	1.576631407
Median	11.19815
Mode	#N/A
Standard Deviation	43.80652704
Sample Variance	1919.011811
Kurtosis	2.190590204
Skewness	-1.282269844
Range	275.2423
Minimum	-186.0347
Maximum	89.2076
Sum	2171.8967
Count	772
Confidence Level(95.0%)	3.094997249

Input Properties 34	
Mean	-0.39957668
Standard Error	0.094267866
Median	-2.1645
Mode	-2.7441
Standard Deviation	2.619222103
Sample Variance	6.860324427
Kurtosis	-1.8324367
Skewness	0.331252314
Range	6.2804
Minimum	-3.1392
Maximum	3.1412
Sum	-308.4732
Count	772
Confidence Level(95.0%)	0.185051995

Input Properties 35	
Mean	-0.70726865
Standard Error	0.08297029
Median	-1.9747
Mode	-2.1325
Standard Deviation	2.30532012
Sample Variance	5.31450084
Kurtosis	-1.73653982
Skewness	0.27720675
Range	6.3191
Minimum	-3.6844
Maximum	2.6347
Sum	-546.0114
Count	772
Confidence Level(95.0%)	0.16287435

Input Properties 36	
Mean	0.54747552
Standard Error	0.10511595
Median	-1.76555
Mode	-1.8716
Standard Deviation	2.9206348
Sample Variance	8.53010764
Kurtosis	-1.82575904
Skewness	0.40447569
Range	7.527
Minimum	-2.6316
Maximum	4.8954
Sum	422.6511
Count	772
Confidence Level(95.0%)	0.20634726

Input Properties 37	
Mean	-0.004393782
Standard Error	0.097382781
Median	-1.96735
Mode	-2.3056
Standard Deviation	2.705769649
Sample Variance	7.321189391
Kurtosis	-1.81357503
Skewness	0.395932151
Range	7.1656
Minimum	-3.1232
Maximum	4.0424
Sum	-3.392
Count	772
Confidence Level(95.0%)	0.191166709

Input Properties 38	
Mean	-0.10429728
Standard Error	0.086272969
Median	-1.8813
Mode	-1.9411
Standard Deviation	2.39708477
Sample Variance	5.746015394
Kurtosis	-1.64421176
Skewness	0.458456031
Range	8.1136
Minimum	-4.2035
Maximum	3.9101
Sum	-80.5175
Count	772
Confidence Level(95.0%)	0.169357657

Input Properties 39	
Mean	0.52266671
Standard Error	0.1110087
Median	-1.9021
Mode	-2.0403
Standard Deviation	3.08436443
Sample Variance	9.51330393
Kurtosis	-1.75079604
Skewness	0.37551805
Range	12.0613
Minimum	-6.8389
Maximum	5.2224
Sum	403.4987
Count	772
Confidence Level(95.0%)	0.217915

Input Properties 40	
Mean	0.03969987
Standard Error	0.10069806
Median	-2.0264
Mode	-2.2353
Standard Deviation	2.79788438
Sample Variance	7.82815698
Kurtosis	-1.60108869
Skewness	0.32586862
Range	13.1204
Minimum	-9.0398
Maximum	4.0806
Sum	30.6483
Count	772
Confidence Level(95.0%)	0.19767475

Input Properties 41	
Mean	0.395088601
Standard Error	0.109962203
Median	-1.97615
Mode	-2.0183
Standard Deviation	3.055287501
Sample Variance	9.334781714
Kurtosis	-1.314572611
Skewness	0.431821935
Range	18.909
Minimum	-11.5602
Maximum	7.3488
Sum	305.0084
Count	772
Confidence Level(95.0%)	0.215860673

Input Properties 42	
Mean	0.178340285
Standard Error	0.109744957
Median	-2.0514
Mode	-2.0804
Standard Deviation	3.049251336
Sample Variance	9.297933709
Kurtosis	-1.31954049
Skewness	0.435393284
Range	17.5761
Minimum	-12.436
Maximum	5.1401
Sum	137.6787
Count	772
Confidence Level(95.0%)	0.215434209

Input Properties 43	
Mean	-0.19318199
Standard Error	0.10023075
Median	-2.13105
Mode	-2.1405
Standard Deviation	2.78490018
Sample Variance	7.75566903
Kurtosis	-1.3710636
Skewness	0.44969311
Range	15.2681
Minimum	-11.3323
Maximum	3.9358
Sum	-149.1365
Count	772
Confidence Level(95.0%)	0.1967574

Input Properties 44	
Mean	0.36152953
Standard Error	0.11775265
Median	-2.1023
Mode	-2.1089
Standard Deviation	3.2717442
Sample Variance	10.7043101
Kurtosis	-1.38459415
Skewness	0.4525202
Range	18.4456
Minimum	-11.8493
Maximum	6.5963
Sum	279.1008
Count	772
Confidence Level(95.0%)	0.23115367

Input Properties 45	
Mean	-0.017048575
Standard Error	0.109928418
Median	-2.1981
Mode	-2.1966
Standard Deviation	3.05434879
Sample Variance	9.329046528
Kurtosis	-1.303069862
Skewness	0.409202153
Range	17.0682
Minimum	-12.0329
Maximum	5.0353
Sum	-13.1615
Count	772
Confidence Level(95.0%)	0.215794352

Input Properties 46	
Mean	-0.23267383
Standard Error	0.103279528
Median	-2.24045
Mode	-2.2372
Standard Deviation	2.869610104
Sample Variance	8.234662152
Kurtosis	-1.28954301
Skewness	0.457517534
Range	19.3609
Minimum	-11.6347
Maximum	7.7262
Sum	-179.6242
Count	772
Confidence Level(95.0%)	0.202742285

Input Properties 47	
Mean	0.17249275
Standard Error	0.11806518
Median	-2.2452
Mode	-2.2639
Standard Deviation	3.28042766
Sample Variance	10.7612057
Kurtosis	-1.36003911
Skewness	0.42879462
Range	18.323
Minimum	-11.9915
Maximum	6.3315
Sum	133.1644
Count	772
Confidence Level(95.0%)	0.23176717

Input Properties 48	
Mean	-0.19229352
Standard Error	0.10955997
Median	-2.34235
Mode	-2.3725
Standard Deviation	3.04411145
Sample Variance	9.26661454
Kurtosis	-1.28302762
Skewness	0.39184436
Range	17.6471
Minimum	-11.8982
Maximum	5.7489
Sum	-148.4506
Count	772
Confidence Level(95.0%)	0.21507107

Input Properties 49	
Mean	0.009862953
Standard Error	0.113421986
Median	-2.3616
Mode	-2.3705
Standard Deviation	3.151417179
Sample Variance	9.931430234
Kurtosis	-1.273576215
Skewness	0.440524602
Range	18.8957
Minimum	-11.8492
Maximum	7.0465
Sum	7.6142
Count	772
Confidence Level(95.0%)	0.22265238

Input Properties 50	
Mean	-0.03042137
Standard Error	0.117069076
Median	-2.40115
Mode	-2.4069
Standard Deviation	3.252751154
Sample Variance	10.58039007
Kurtosis	-1.33826502
Skewness	0.410988833
Range	18.3137
Minimum	-12.0745
Maximum	6.2392
Sum	-23.4853
Count	772
Confidence Level(95.0%)	0.229811778

Input Properties 51	
Mean	-0.34267915
Standard Error	0.10898257
Median	-2.48195
Mode	-2.5015
Standard Deviation	3.02806845
Sample Variance	9.16919856
Kurtosis	-1.25879411
Skewness	0.3947678
Range	18.8907
Minimum	-11.9397
Maximum	6.951
Sum	-264.5483
Count	772
Confidence Level(95.0%)	0.21393761

Input Properties 52	
Mean	0.01180518
Standard Error	0.12087943
Median	-2.47835
Mode	-2.4973
Standard Deviation	3.35862131
Sample Variance	11.2803371
Kurtosis	-1.34171482
Skewness	0.4615571
Range	18.7508
Minimum	-12.0291
Maximum	6.7217
Sum	9.1136
Count	772
Confidence Level(95.0%)	0.23729166

Input Properties 53	
Mean	-0.232807124
Standard Error	0.115269608
Median	-2.55655
Mode	-2.5636
Standard Deviation	3.202753135
Sample Variance	10.25762764
Kurtosis	-1.341647783
Skewness	0.412026135
Range	18.4581
Minimum	-12.1364
Maximum	6.3217
Sum	-179.7271
Count	772
Confidence Level(95.0%)	0.226279343

Input Properties 54	
Mean	-0.45912163
Standard Error	0.109294168
Median	-2.6163
Mode	-2.6135
Standard Deviation	3.036726203
Sample Variance	9.221706032
Kurtosis	-1.27315196
Skewness	0.420396725
Range	19.5663
Minimum	-12.057
Maximum	7.5093
Sum	-354.4419
Count	772
	0.214549289

Input Properties 55	
Mean	-0.16577655
Standard Error	0.12086104
Median	-2.6155
Mode	-2.6433
Standard Deviation	3.35811052
Sample Variance	11.2769063
Kurtosis	-1.34083561
Skewness	0.43680011
Range	18.6925
Minimum	-12.1797
Maximum	6.5128
Sum	-127.9795
Count	772
Confidence Level(95.0%)	0.23725558

Input Properties 56	
Mean	-0.44717163
Standard Error	0.11420666
Median	-2.70945
Mode	-2.7143
Standard Deviation	3.17321917
Sample Variance	10.0693199
Kurtosis	-1.2958236
Skewness	0.38624884
Range	18.6813
Minimum	-12.2084
Maximum	6.4729
Sum	-345.2165
Count	772
Confidence Level(95.0%)	0.22419272

Input Properties 57	
Mean	-0.375363212
Standard Error	0.114785999
Median	-2.7512
Mode	-2.7509
Standard Deviation	3.189316125
Sample Variance	10.17173734
Kurtosis	-1.248452873
Skewness	0.446874906
Range	18.8698
Minimum	-12.2017
Maximum	6.6681
Sum	-289.7804
Count	772
Confidence Level(95.0%)	0.225329998

Input Properties 58	
Mean	-0.36751308
Standard Error	0.118988676
Median	-2.77665
Mode	-2.7933
Standard Deviation	3.306087045
Sample Variance	10.93021155
Kurtosis	-1.33996195
Skewness	0.426430947
Range	18.6998
Minimum	-12.3051
Maximum	6.3947
Sum	-283.7201
Count	772
Confidence Level(95.0%)	0.233580039

Input Properties 59	
Mean	-0.62837798
Standard Error	0.11272779
Median	-2.8577
Mode	-2.8577
Standard Deviation	3.13212902
Sample Variance	9.81023223
Kurtosis	-1.28653285
Skewness	0.39508501
Range	18.8177
Minimum	-12.3065
Maximum	6.5112
Sum	-485.1078
Count	772
Confidence Level(95.0%)	0.22128964

Input Properties 60	
Mean	-0.41264676
Standard Error	0.120311
Median	-2.8728
Mode	-2.891
Standard Deviation	3.34282766
Sample Variance	11.1744968
Kurtosis	-1.292048
Skewness	0.4676096
Range	18.8305
Minimum	-12.3492
Maximum	6.4813
Sum	-318.5633
Count	772
Confidence Level(95.0%)	0.23617582

Input Properties 61	
Mean	-0.589007254
Standard Error	0.116484782
Median	-2.9435
Mode	-2.9467
Standard Deviation	3.236516622
Sample Variance	10.47503985
Kurtosis	-1.329930444
Skewness	0.42232883
Range	18.7625
Minimum	-12.4155
Maximum	6.347
Sum	-454.7136
Count	772
Confidence Level(95.0%)	0.228664784

Input Properties 62	
Mean	-0.75474456
Standard Error	0.113491152
Median	-3.0014
Mode	-3.0016
Standard Deviation	3.153338934
Sample Variance	9.943546431
Kurtosis	-1.18183638
Skewness	0.453340651
Range	18.9125
Minimum	-12.4294
Maximum	6.4831
Sum	-582.6628
Count	772
Confidence Level(95.0%)	0.222788155

Input Properties 63	
Mean	-0.61355803
Standard Error	0.11877692
Median	-3.0096
Mode	-3.0348
Standard Deviation	3.30020336
Sample Variance	10.8913422
Kurtosis	-1.29989748
Skewness	0.4468681
Range	18.8231
Minimum	-12.4862
Maximum	6.3369
Sum	-473.6668
Count	772
Confidence Level(95.0%)	0.23316435

Input Properties 64	
Mean	-0.83290466
Standard Error	0.11462482
Median	-3.0978
Mode	-3.0978
Standard Deviation	3.1848377
Sample Variance	10.1431912
Kurtosis	-1.19606514
Skewness	0.43202454
Range	18.8373
Minimum	-12.5253
Maximum	6.312
Sum	-643.0024
Count	772
Confidence Level(95.0%)	0.22501359

Table of Statistical Description of Data

OUTLET PROPERTIES

Outlet Properties P_Target	
Mean	3.182642487
Standard Error	0.032578861
Median	3.5
Mode	3.5
Standard Deviation	0.905200001
Sample Variance	0.819387042
Kurtosis	2.306954877
Skewness	-1.697309901
Range	5.5
Minimum	1
Maximum	6.5
Sum	2457
Count	772
Confidence Level(95.0%)	0.063953746

Outlet Properties I_Target	
Mean	20.42227979
Standard Error	0.313798793
Median	21
Mode	21
Standard Deviation	8.718864321
Sample Variance	76.01859506
Kurtosis	5.702930782
Skewness	0.823387913
Range	52
Minimum	-1
Maximum	51
Sum	15766
Count	772
Confidence Level(95.0%)	0.616000923

Outlet Properties D_Target	
Mean	18.1094286
Standard Error	0.517465
Median	14.8656
Mode	3.05
Standard Deviation	14.377707
Sample Variance	206.718459
Kurtosis	0.09499789
Skewness	0.82788876
Range	78.8223
Minimum	0.1162
Maximum	78.9385
Sum	13980.4789
Count	772
Confidence Level(95.0%)	1.0158067

APPENDIX F

RESULT OF PREDICTION WITH NEURAL NETWORK

Result of Prediction with Neural Network (normalized value)

P Controller

Training				Validation				Testing			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
1	0.9536	0.0464	0.0022	0.4	0.3302	0.0698	0.0049	0.4	0.6285	0.2285	0.0522
0.4	0.4011	0.0011	0.0000	1	0.3762	0.6238	0.3891	0.4	0.9233	0.5233	0.2738
0.4	0.4009	0.0009	0.0000	1	0.4037	0.5963	0.3556	1	0.7721	0.2279	0.0519
0.4	0.3999	0.0001	0.0000	1	0.2542	0.7458	0.5562	0.4	0.3559	0.0441	0.0019
0.4	0.4125	0.0125	0.0002	1	0.2945	0.7055	0.4977	0.4	0.4238	0.0238	0.0006
0	0.0299	0.0299	0.0009	0.5	0.6946	0.1946	0.0379	0.4	0.7611	0.3611	0.1304
0.4	0.3904	0.0096	0.0001	0.4	0.204	0.196	0.0384	0.4	0.0302	0.3698	0.1368
1	0.8456	0.1544	0.0238	0	0.0902	0.0902	0.0081	0.4	0.5632	0.1632	0.0266
0.4	0.3965	0.0035	0.0000	1	0.2896	0.7104	0.5047	0.4	0.3631	0.0369	0.0014
0.4	0.4016	0.0016	0.0000	0.5	0.5495	0.0495	0.0025	0.4	0.3615	0.0385	0.0015
0.4	0.3683	0.0317	0.0010	1	0.749	0.251	0.0630	0.4	0.3458	0.0542	0.0029
0	0.1104	0.1104	0.0122	1	0.4025	0.5975	0.3570	0.4	0.0888	0.3112	0.0968
0.4	0.4082	0.0082	0.0001	0.4	0.412	0.012	0.0001	0.4	0.3172	0.0828	0.0069
1	0.7945	0.2055	0.0422	0.4	0.4082	0.0082	0.0001	0.4	0.435	0.035	0.0012
0.4	0.4071	0.0071	0.0001	1	0.4158	0.5842	0.3413	0.4	0.3973	0.0027	0.0000
0.4	0.3988	0.0012	0.0000	0.4	0.4053	0.0053	0.0000	0.4	0.9781	0.5781	0.3342
1	0.6638	0.3362	0.1130	1	0.946	0.054	0.0029	0.4	0.4444	0.0444	0.0020
0.4	0.4125	0.0125	0.0002	0.5	0.32	0.18	0.0324	0.4	0.4323	0.0323	0.0010
1	0.9082	0.0918	0.0084	0.4	0.2847	0.1153	0.0133	0.4	0.4228	0.0228	0.0005
0.4	0.3953	0.0047	0.0000	1	0.6809	0.3191	0.1018	0.4	0.3158	0.0842	0.0071
0.4	0.3966	0.0034	0.0000	0.4	0.1816	0.2184	0.0477	0.4	0.4269	0.0269	0.0007
0	0.1681	0.1681	0.0283	0	0.8899	0.8899	0.7919	0.4	0.5443	0.1443	0.0208
0.5	0.5089	0.0089	0.0001	0.4	0.2296	0.1704	0.0290	0.4	0.4359	0.0359	0.0013
0.4	0.3864	0.0136	0.0002	1	0.222	0.778	0.6053	0.4	0.4038	0.0038	0.0000
0.4	0.3244	0.0756	0.0057	0.8	0.1897	0.6103	0.3725	0.4	0.4194	0.0194	0.0004
0.4	0.399	0.001	0.0000	0.4	0.1829	0.2171	0.0471	0.4	0.3723	0.0277	0.0008
0.4	0.4528	0.0528	0.0028	0.4	0.3898	0.0102	0.0001	0.4	0.468	0.068	0.0046
0	0.1256	0.1256	0.0158	0.4	0.7609	0.3609	0.1302	0.4	0.3513	0.0487	0.0024
1	1	0	0.0000	0.4	0.4241	0.0241	0.0006	0.4	0.4239	0.0239	0.0006
0.4	0.2285	0.1715	0.0294	0	0.0064	0.0064	0.0000	0.4	0.4098	0.0098	0.0001

Training				Validation				Testing			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.4	0.4865	0.0865	0.0075	0.4	0.3444	0.0556	0.0031	0.4	0.3926	0.0074	0.0001
0	0.0953	0.0953	0.0091	0.4	0.3463	0.0537	0.0029	0.4	0.3962	0.0038	0.0000
0.4	0.389	0.011	0.0001	0.4	0.0753	0.3247	0.1054	0.4	0.5765	0.1765	0.0312
0	0.0711	0.0711	0.0051	0.4	0.4724	0.0724	0.0052	0.4	0.3602	0.0398	0.0016
0.5	0.4993	0.0007	0.0000	0.4	0.4452	0.0452	0.0020	0.4	0.3662	0.0338	0.0011
0.4	0.41	0.01	0.0001	0.4	0.0293	0.3707	0.1374	0.4	0.382	0.018	0.0003
0.4	0.4051	0.0051	0.0000	0.4	0.8304	0.4304	0.1852	0.4	0.419	0.019	0.0004
0.4	0.2635	0.1365	0.0186	0.4	0.3971	0.0029	0.0000	0.4	0.3974	0.0026	0.0000
0.4	0.5412	0.1412	0.0199	0.4	0.3752	0.0248	0.0006	0.4	0.4064	0.0064	0.0000
0	0.0678	0.0678	0.0046	0.4	0.3873	0.0127	0.0002	0.4	0.4228	0.0228	0.0005
0.4	0.3745	0.0255	0.0007	0	0.0027	0.0027	0.0000	0.4	0.4102	0.0102	0.0001
0.4	0.1508	0.2492	0.0621	0.4	0.3782	0.0218	0.0005	0.4	0.4127	0.0127	0.0002
0.4	0.3808	0.0192	0.0004	0	0.0858	0.0858	0.0074	0.4	0.3641	0.0359	0.0013
0	0.3406	0.3406	0.1160	0.4	0.4067	0.0067	0.0000	0.4	0.3929	0.0071	0.0001
0.4	0.4406	0.0406	0.0016	0.4	0.2652	0.1348	0.0182	0.4	0.3795	0.0205	0.0004
0	0.1512	0.1512	0.0229	0.4	0.4085	0.0085	0.0001	0.4	0.4044	0.0044	0.0000
0.4	0.4184	0.0184	0.0003	0	0.8444	0.8444	0.7130	0.4	0.3929	0.0071	0.0001
0.4	0.4219	0.0219	0.0005	0	0.0733	0.0733	0.0054	0.4	0.3943	0.0057	0.0000
0	0.0298	0.0298	0.0009	0	0.4471	0.4471	0.1999	0.4	0.4036	0.0036	0.0000
0	0.2763	0.2763	0.0763	0	0.0113	0.0113	0.0001	0.4	0.3912	0.0088	0.0001
0	0.0824	0.0824	0.0068	0.4	0.383	0.017	0.0003	0.4	0.4042	0.0042	0.0000
0.4	0.4315	0.0315	0.0010	0.4	0.44	0.04	0.0016	0.4	0.4027	0.0027	0.0000
0.4	0.3748	0.0252	0.0006	0.4	0.2279	0.1721	0.0296	0.4	0.3878	0.0122	0.0001
0.4	0.4062	0.0062	0.0000	1	0.4568	0.5432	0.2951	0.4	0.3607	0.0393	0.0015
0	0.023	0.023	0.0005	0.4	0.5833	0.1833	0.0336	0.4	0.401	0.001	0.0000
0.4	0.3019	0.0981	0.0096	1	0.4203	0.5797	0.3361	0.4	0.3892	0.0108	0.0001
0	0.1156	0.1156	0.0134	0.4	0.0661	0.3339	0.1115	0	0.0463	0.0463	0.0021
0.4	0.4291	0.0291	0.0008	0.4	0.0013	0.3987	0.1590	0	0.3685	0.3685	0.1358
0.4	0.4285	0.0285	0.0008	0.4	0.3466	0.0534	0.0029	0	0.3849	0.3849	0.1481
0.4	0.4377	0.0377	0.0014	0.4	0.434	0.034	0.0012	0	0.4105	0.4105	0.1685
0.4	0.383	0.017	0.0003	0.4	0.3794	0.0206	0.0004	0	0.3758	0.3758	0.1412
0.4	0.3193	0.0807	0.0065	0.4	0.3231	0.0769	0.0059	0	0.4042	0.4042	0.1634
0.4	0.3853	0.0147	0.0002	0.4	0.4289	0.0289	0.0008	0.4	0.2884	0.1116	0.0125
0.4	0.3205	0.0795	0.0063	0.4	0.458	0.058	0.0034	0.4	0.4166	0.0166	0.0003
0.4	0.386	0.014	0.0002	0.4	0.4378	0.0378	0.0014	0.4	0.0752	0.3248	0.1055

Training				Validation				Testing			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.4	0.3226	0.0774	0.0060	0.4	0.3982	0.0018	0.0000	0.4	0.3823	0.0177	0.0003
0.4	0.3982	0.0018	0.0000	0.4	0.487	0.087	0.0076	0.4	0.4026	0.0026	0.0000
0	0.0072	0.0072	0.0001	0.4	0.5029	0.1029	0.0106	0.4	0.3885	0.0115	0.0001
0	0.0067	0.0067	0.0000	0.4	0.8213	0.4213	0.1775	0.4	0.414	0.014	0.0002
0.4	0.3815	0.0185	0.0003	0.4	0.3962	0.0038	0.0000	0.4	0.6322	0.2322	0.0539
0.4	0.3544	0.0456	0.0021	0.4	0.38	0.02	0.0004	0.4	0.4055	0.0055	0.0000
0.4	0.3999	0.0001	0.0000	0.4	0.3861	0.0139	0.0002	0.4	0.3757	0.0243	0.0006
0.4	0.4396	0.0396	0.0016	0	0.0155	0.0155	0.0002	0.4	0.3809	0.0191	0.0004
0.4	0.4282	0.0282	0.0008	0	0.4017	0.4017	0.1614	1	0.4129	0.5871	0.3447
0.4	0.3559	0.0441	0.0019	0	0.0407	0.0407	0.0017	0.4	0.3658	0.0342	0.0012
1	0.9852	0.0148	0.0002	0	0.0831	0.0831	0.0069	0.4	0.4402	0.0402	0.0016
0.4	0.3886	0.0114	0.0001	0	0.4411	0.4411	0.1946	0.4	0.4404	0.0404	0.0016
0.4	0.4251	0.0251	0.0006	0.4	0.4304	0.0304	0.0009	0.4	0.3664	0.0336	0.0011
0.4	0.4424	0.0424	0.0018	0	0.3905	0.3905	0.1525	0.4	0.3833	0.0167	0.0003
0.4	0.4434	0.0434	0.0019	0.4	0.4279	0.0279	0.0008	0.4	0.4126	0.0126	0.0002
0.4	0.4233	0.0233	0.0005	0	0.0013	0.0013	0.0000	0.4	0.374	0.026	0.0007
0.4	0.3471	0.0529	0.0028	0.4	0.4306	0.0306	0.0009	0.4	0.4019	0.0019	0.0000
0.8	0.4446	0.3554	0.1263	0.4	0.3407	0.0593	0.0035	0.4	0.3567	0.0433	0.0019
0.4	0.4395	0.0395	0.0016	0.4	0.4015	0.0015	0.0000	0.4	0.3514	0.0486	0.0024
0.4	0.4275	0.0275	0.0008	0.4	0.3965	0.0035	0.0000	0.4	0.3855	0.0145	0.0002
0	0.0241	0.0241	0.0006	0.4	0.3729	0.0271	0.0007	0.4	0.4709	0.0709	0.0050
0.4	0.411	0.011	0.0001	0	0.0011	0.0011	0.0000	0.4	0.3957	0.0043	0.0000
0.4	0.3787	0.0213	0.0005	0.4	0.4587	0.0587	0.0034	0.4	0.3653	0.0347	0.0012
0.4	0.4329	0.0329	0.0011	0.4	0.418	0.018	0.0003	0.4	0.3889	0.0111	0.0001
0.4	0.4117	0.0117	0.0001	0.4	0.4517	0.0517	0.0027	0.4	0.409	0.009	0.0001
0.4	0.424	0.024	0.0006	0.4	0.4144	0.0144	0.0002	0.4	0.4066	0.0066	0.0000
0.4	0.3806	0.0194	0.0004	1	0.4291	0.5709	0.3259	0.4	0.3997	0.0003	0.0000
0.4	0.3969	0.0031	0.0000	0.4	0.3932	0.0068	0.0000	0.4	0.3892	0.0108	0.0001
0	0.0543	0.0543	0.0029	0.4	0.4145	0.0145	0.0002	0.4	0.3483	0.0517	0.0027
0	0.1099	0.1099	0.0121	0.4	0.3922	0.0078	0.0001	0.4	0.4337	0.0337	0.0011
0	0.3772	0.3772	0.1423	0.4	0.3966	0.0034	0.0000	0.4	0.3602	0.0398	0.0016
0.4	0.4064	0.0064	0.0000	0	0.0678	0.0678	0.0046	0.4	0.3597	0.0403	0.0016
0.4	0.3693	0.0307	0.0009	0.4	0.3919	0.0081	0.0001	0.4	0.3872	0.0128	0.0002
0.4	0.4955	0.0955	0.0091	0.4	0.4181	0.0181	0.0003	0.4	0.3562	0.0438	0.0019
0.4	0.4404	0.0404	0.0016	0.4	0.4663	0.0663	0.0044	0.4	0.3773	0.0227	0.0005

Training				Validation				Testing			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.4	0.4169	0.0169	0.0003	0.4	0.4263	0.0263	0.0007	0.4	0.3646	0.0354	0.0013
0.4	0.4437	0.0437	0.0019	0.4	0.3702	0.0298	0.0009	0.4	0.4436	0.0436	0.0019
0.4	0.4824	0.0824	0.0068	0.4	0.3675	0.0325	0.0011	0.4	0.3782	0.0218	0.0005
0.4	0.3653	0.0347	0.0012	0.4	0.378	0.022	0.0005	0.4	1	0.6	0.3600
0.4	0.4143	0.0143	0.0002	0.4	0.423	0.023	0.0005	0.4	0.3881	0.0119	0.0001
0.4	0.347	0.053	0.0028	0.4	0.403	0.003	0.0000	0.4	0.4288	0.0288	0.0008
0.4	0.4176	0.0176	0.0003	0.4	0.4245	0.0245	0.0006			Sum of Error	2.8703
0.4	0.3033	0.0967	0.0094	0.4	0.3896	0.0104	0.0001			MSE	0.0271
0.4	0.4381	0.0381	0.0015	0.4	0.4113	0.0113	0.0001				
0.4	0.4202	0.0202	0.0004	0.4	0.3738	0.0262	0.0007				
0.4	0.3743	0.0257	0.0007	0.4	0.3959	0.0041	0.0000				
0.4	0.4134	0.0134	0.0002	0.4	0.4048	0.0048	0.0000				
0.4	0.4345	0.0345	0.0012	0.4	0.4888	0.0888	0.0079				
1	0.4278	0.5722	0.3274	0.4	0.45	0.05	0.0025				
1	0.9854	0.0146	0.0002	0.4	0.4244	0.0244	0.0006				
0.4	0.3913	0.0087	0.0001	0	0.4101	0.4101	0.1682				
0.4	0.4275	0.0275	0.0008	0	0.4135	0.4135	0.1710				
0.4	0.3908	0.0092	0.0001	0.3	0.3406	0.0406	0.0016				
0.4	0.4264	0.0264	0.0007	0.3	0.4383	0.1383	0.0191				
0.4	0.4034	0.0034	0.0000	0.3	0.3898	0.0898	0.0081				
0.4	0.4274	0.0274	0.0008	0.4	0.3786	0.0214	0.0005				
0.4	0.3938	0.0062	0.0000	0.4	0.4023	0.0023	0.0000				
0.4	0.4083	0.0083	0.0001	0.4	0.3891	0.0109	0.0001				
0.4	0.408	0.008	0.0001	0.4	0.4185	0.0185	0.0003				
0.4	0.425	0.025	0.0006	0.4	0.4125	0.0125	0.0002				
0.4	0.4346	0.0346	0.0012	0.4	0.5137	0.1137	0.0129				
0.4	0.425	0.025	0.0006	0.4	0.3937	0.0063	0.0000				
0.4	0.4093	0.0093	0.0001	0.4	0.4261	0.0261	0.0007				
0.4	0.4248	0.0248	0.0006	0.4	0.4315	0.0315	0.0010				
0.4	0.3859	0.0141	0.0002	0.4	0.4269	0.0269	0.0007				
0.4	0.3862	0.0138	0.0002	0.4	0.397	0.003	0.0000				
0.4	0.3974	0.0026	0.0000	0	0.0342	0.0342	0.0012				
0.4	0.3803	0.0197	0.0004	1	0.5001	0.4999	0.2499				
0.4	0.391	0.009	0.0001	0	0.3961	0.3961	0.1569				
0.4	0.3943	0.0057	0.0000	0	0.3822	0.3822	0.1461				

Training				Validation			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.4	0.389	0.011	0.0001	0.4	0.6066	0.2066	0.0427
0.4	0.3878	0.0122	0.0001	0.4	0.4085	0.0085	0.0001
0.4	0.4074	0.0074	0.0001	0.4	0.3765	0.0235	0.0006
0.4	0.4669	0.0669	0.0045	0.4	0.392	0.008	0.0001
0.4	0.4247	0.0247	0.0006	0.4	0.5301	0.1301	0.0169
0.4	0.3926	0.0074	0.0001	0.4	0.4028	0.0028	0.0000
0.4	0.3816	0.0184	0.0003	0.4	0.3874	0.0126	0.0002
0.4	0.4193	0.0193	0.0004	0.4	0.3817	0.0183	0.0003
0.4	0.4164	0.0164	0.0003	0.4	0.3917	0.0083	0.0001
0.4	0.4153	0.0153	0.0002	0.4	0.4183	0.0183	0.0003
0.4	0.3979	0.0021	0.0000	0.4	0.4103	0.0103	0.0001
0.4	0.4134	0.0134	0.0002	0.4	0.4239	0.0239	0.0006
0.4	0.3914	0.0086	0.0001	0.4	0.3584	0.0416	0.0017
0.4	0.4016	0.0016	0.0000	0	0.0238	0.0238	0.0006
0.4	0.4039	0.0039	0.0000	0	0.3964	0.3964	0.1571
0.4	0.4185	0.0185	0.0003	0.4	0.4088	0.0088	0.0001
0.4	0.3851	0.0149	0.0002	1	0.72	0.28	0.0784
0.4	0.3967	0.0033	0.0000	0.4	0.4256	0.0256	0.0007
0.4	0.3988	0.0012	0.0000	0.4	0.3854	0.0146	0.0002
0.4	0.3862	0.0138	0.0002	0.4	0.4662	0.0662	0.0044
0.4	0.3896	0.0104	0.0001	1	0.2114	0.7886	0.6219
0.4	0.4643	0.0643	0.0041	0.4	0.4283	0.0283	0.0008
0.4	0.3673	0.0327	0.0011	0.4	0.4158	0.0158	0.0002
0.4	0.4022	0.0022	0.0000	0.4	0.3986	0.0014	0.0000
0.4	0.39	0.01	0.0001	0.4	0.4511	0.0511	0.0026
0.4	0.4113	0.0113	0.0001	0.3	0.3943	0.0943	0.0089
0.4	0.39	0.01	0.0001	0.4	0.3512	0.0488	0.0024
0.4	0.3605	0.0395	0.0016	0.4	0.4131	0.0131	0.0002
0.4	0.4257	0.0257	0.0007	0.4	0.3919	0.0081	0.0001
0.4	0.4047	0.0047	0.0000	0.4	0.4064	0.0064	0.0000
0.4	0.3889	0.0111	0.0001	0.4	0.38	0.02	0.0004
0.4	0.4029	0.0029	0.0000	0.4	0.3906	0.0094	0.0001
0.4	0.417	0.017	0.0003	0.4	0.4153	0.0153	0.0002
0.4	0.4161	0.0161	0.0003	0.4	0.3947	0.0053	0.0000
0.4	0.3888	0.0112	0.0001	0.4	0.3856	0.0144	0.0002

Training				Validation			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.4	0.3998	0.0002	0.0000	0	0.5727	0.5727	0.3280
0.4	0.4113	0.0113	0.0001	0.4	0.4024	0.0024	0.0000
0.4	0.4097	0.0097	0.0001	0.4	0.3923	0.0077	0.0001
0.4	0.3755	0.0245	0.0006	0.4	0.3702	0.0298	0.0009
0.4	0.3867	0.0133	0.0002	0.4	0.2811	0.1189	0.0141
0.4	0.4784	0.0784	0.0061	0.4	0.4472	0.0472	0.0022
0.4	0.3863	0.0137	0.0002	0.4	0.3809	0.0191	0.0004
0.4	0.3717	0.0283	0.0008	0.4	0.4014	0.0014	0.0000
0	0.4086	0.4086	0.1670	0.4	0.4154	0.0154	0.0002
0.4	0.4151	0.0151	0.0002	0.4	0.3704	0.0296	0.0009
0.4	0.3901	0.0099	0.0001	0.4	0.3875	0.0125	0.0002
0.4	0.3951	0.0049	0.0000	0.4	0.3631	0.0369	0.0014
0.4	0.3942	0.0058	0.0000	0.4	0.3819	0.0181	0.0003
0.4	0.3691	0.0309	0.0010	0.4	0.3701	0.0299	0.0009
0	0.0265	0.0265	0.0007	0.4	0.3838	0.0162	0.0003
0.4	0.3516	0.0484	0.0023	0.4	0.3702	0.0298	0.0009
0.9	0.4837	0.4163	0.1733	0.4	0.3923	0.0077	0.0001
0.4	0.3731	0.0269	0.0007	0.4	0.0699	0.3301	0.1090
0.4	0.4067	0.0067	0.0000	0.4	0.4136	0.0136	0.0002
0.4	0.3582	0.0418	0.0017	0.4	0.3887	0.0113	0.0001
0.4	0.425	0.025	0.0006	0.4	0.422	0.022	0.0005
0.4	0.4015	0.0015	0.0000	0	0.069	0.069	0.0048
0.4	0.3819	0.0181	0.0003	0	0.4102	0.4102	0.1683
0.4	0.3675	0.0325	0.0011	0.4	0.4502	0.0502	0.0025
0.4	0.3946	0.0054	0.0000	0.4	0.3779	0.0221	0.0005
0.4	0.3636	0.0364	0.0013	0.4	0.3862	0.0138	0.0002
0.4	0.3764	0.0236	0.0006	0.4	0.4031	0.0031	0.0000
0.4	0.3897	0.0103	0.0001	0.4	0.3917	0.0083	0.0001
0.4	0.4047	0.0047	0.0000	0.4	0.4028	0.0028	0.0000
0.4	0.418	0.018	0.0003	0.4	0.3958	0.0042	0.0000
0.4	0.3965	0.0035	0.0000	0.4	1	0.6	0.3600
0.4	0.4001	1E-04	0.0000	0	0.3856	0.3856	0.1487
0.4	0.3919	0.0081	0.0001	0.3	0.3969	0.0969	0.0094
0.4	0.3774	0.0226	0.0005	0.4	0.3281	0.0719	0.0052
0.4	0.4364	0.0364	0.0013	0.3	0.4019	0.1019	0.0104

Training				Validation			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.4	0.3862	0.0138	0.0002	0.3	0.4008	0.1008	0.0102
0.4	0.4028	0.0028	0.0000	0	0.3999	0.3999	0.1599
0.4	0.3728	0.0272	0.0007	0	0.3928	0.3928	0.1543
0.4	0.4032	0.0032	0.0000	0	0.016	0.016	0.0003
0.9	0.4118	0.4882	0.2383	0	0.3649	0.3649	0.1332
0.4	0.4056	0.0056	0.0000	0	0.3717	0.3717	0.1382
0.4	0.3857	0.0143	0.0002	0	0.412	0.412	0.1697
0.4	0.4106	0.0106	0.0001	0	0.3887	0.3887	0.1511
0.4	0.4469	0.0469	0.0022	0.4	0.3899	0.0101	0.0001
0.4	0.4158	0.0158	0.0002	0.4	0.3821	0.0179	0.0003
0.4	0.4055	0.0055	0.0000	0.4	0.3853	0.0147	0.0002
0.4	0.387	0.013	0.0002	0.4	0.3966	0.0034	0.0000
0.4	0.3935	0.0065	0.0000	0.4	0.3651	0.0349	0.0012
0.4	0.412	0.012	0.0001	0.4	0.3693	0.0307	0.0009
0.4	0.3552	0.0448	0.0020	0.4	0.4098	0.0098	0.0001
0.4	0.3965	0.0035	0.0000	0.4	0.4342	0.0342	0.0012
0.4	0.3664	0.0336	0.0011	0.4	0.3588	0.0412	0.0017
0.4	0.3576	0.0424	0.0018	0.4	0.3909	0.0091	0.0001
0.4	0.4334	0.0334	0.0011	0.4	0.3764	0.0236	0.0006
0.4	0.4076	0.0076	0.0001	0.4	0.3013	0.0987	0.0097
0.4	0.4046	0.0046	0.0000	0.4	0.3751	0.0249	0.0006
0.4	0.3706	0.0294	0.0009	0.4	0.3578	0.0422	0.0018
0.4	0.3697	0.0303	0.0009	0.4	0.4266	0.0266	0.0007
0.4	0.4073	0.0073	0.0001	0.4	0.4005	0.0005	0.0000
0	0.3682	0.3682	0.1356	0.4	0.4005	0.0005	0.0000
0.4	0.4376	0.0376	0.0014	0.4	0.39	0.01	0.0001
0.4	0.3819	0.0181	0.0003	0.4	0.382	0.018	0.0003
0.4	0.4125	0.0125	0.0002	0.4	0.3826	0.0174	0.0003
0	0.0367	0.0367	0.0013	0.4	0.4105	0.0105	0.0001
0	0.3771	0.3771	0.1422	0.4	0.3951	0.0049	0.0000
0.4	0.377	0.023	0.0005	0.4	0.3631	0.0369	0.0014
0.4	0.4141	0.0141	0.0002	0.4	0.3517	0.0483	0.0023
0.4	0.3909	0.0091	0.0001	0.4	0.4226	0.0226	0.0005
0.4	0.3827	0.0173	0.0003	0.4	0.4133	0.0133	0.0002
0.4	0.3936	0.0064	0.0000	0.4	0.3791	0.0209	0.0004

Training				Validation			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.4	0.3837	0.0163	0.0003	0.4	0.3798	0.0202	0.0004
0.4	0.4445	0.0445	0.0020	0.4	0.3582	0.0418	0.0017
0.4	0.4394	0.0394	0.0016	0.4	0.3644	0.0356	0.0013
0.4	0.3988	0.0012	0.0000	0.4	0.4155	0.0155	0.0002
0.4	0.3592	0.0408	0.0017	1	0.697	0.303	0.0918
0.4	0.4187	0.0187	0.0003	0.7	0.4143	0.2857	0.0816
0.4	0.4038	0.0038	0.0000	0.4	0.3437	0.0563	0.0032
0.4	0.3668	0.0332	0.0011	0.4	0.3461	0.0539	0.0029
0.4	0.4093	0.0093	0.0001	0.4	0.3488	0.0512	0.0026
0.4	0.376	0.024	0.0006	0.4	0.3586	0.0414	0.0017
0.4	0.3704	0.0296	0.0009	0.4	0.386	0.014	0.0002
0.4	0.3916	0.0084	0.0001	0.4	0.433	0.033	0.0011
0.4	0.3764	0.0236	0.0006	0.4	0.369	0.031	0.0010
0.4	0.4073	0.0073	0.0001	0.4	0.3686	0.0314	0.0010
0.4	0.4042	0.0042	0.0000	0.4	0.6415	0.2415	0.0583
0.4	0.4064	0.0064	0.0000	0.4	0.3988	0.0012	0.0000
0.4	0.3956	0.0044	0.0000	0.4	0.4268	0.0268	0.0007
0.4	0.4053	0.0053	0.0000	0.4	0.3998	0.0002	0.0000
0.4	0.3982	0.0018	0.0000	0.4	0.3761	0.0239	0.0006
0.4	0.401	0.001	0.0000	0.4	0.3927	0.0073	0.0001
0.4	0.3962	0.0038	0.0000	0.4	0.3666	0.0334	0.0011
0.4	0.4036	0.0036	0.0000	0.4	0.3656	0.0344	0.0012
0.4	0.3978	0.0022	0.0000	0.4	0.4456	0.0456	0.0021
0.3	0.3741	0.0741	0.0055	0.4	0.4054	0.0054	0.0000
0.4	0.3866	0.0134	0.0002	0.4	0.3997	0.0003	0.0000
0.3	0.3619	0.0619	0.0038	0.4	0.3626	0.0374	0.0014
0.4	0.4198	0.0198	0.0004	0.4	0.0301	0.3699	0.1368
0.3	0.3638	0.0638	0.0041	0.4	0.3966	0.0034	0.0000
0.3	0.3642	0.0642	0.0041	0.4	0.3808	0.0192	0.0004
0.3	0.3705	0.0705	0.0050	0.4	0.3761	0.0239	0.0006
0.4	0.3953	0.0047	0.0000	0.4	0.421	0.021	0.0004
0.4	0.353	0.047	0.0022	0.4	0.3519	0.0481	0.0023
0.4	0.3981	0.0019	0.0000	0.4	0.3662	0.0338	0.0011
0.4	0.3662	0.0338	0.0011	0.4	0.4183	0.0183	0.0003
0.4	0.3855	0.0145	0.0002	0.4	0.4113	0.0113	0.0001

Training				Validation			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.4	0.3727	0.0273	0.0007	0.4	0.4	0	0.0000
0.4	0.4348	0.0348	0.0012	0.4	0.3956	0.0044	0.0000
0.4	0.4003	0.0003	0.0000	0.4	0.3609	0.0391	0.0015
0.4	0.3561	0.0439	0.0019	0.4	0.3584	0.0416	0.0017
0.4	0.3767	0.0233	0.0005	0.4	0.356	0.044	0.0019
0.4	0.3592	0.0408	0.0017	0.4	0.4069	0.0069	0.0000
0.4	0.4008	0.0008	0.0000	0.4	0.362	0.038	0.0014
0.4	0.3929	0.0071	0.0001	0.4	0.3606	0.0394	0.0016
1	0.9793	0.0207	0.0004	0.4	0.3775	0.0225	0.0005
0.4	0.3527	0.0473	0.0022	0.4	0.343	0.057	0.0032
0.4	0.3643	0.0357	0.0013	0.4	0.4257	0.0257	0.0007
0.4	0.3496	0.0504	0.0025	0.4	0.407	0.007	0.0000
0.4	0.3505	0.0495	0.0025	0.4	0.3953	0.0047	0.0000
0.4	0.3963	0.0037	0.0000	0.4	0.3323	0.0677	0.0046
0.4	0.4043	0.0043	0.0000	0.4	0.4101	0.0101	0.0001
0.4	0.4081	0.0081	0.0001	0.4	0.3527	0.0473	0.0022
0.4	0.3758	0.0242	0.0006	0.4	0.3948	0.0052	0.0000
0.4	0.3922	0.0078	0.0001	0.4	0.3638	0.0362	0.0013
0.4	0.4046	0.0046	0.0000	0.4	0.4125	0.0125	0.0002
0.4	0.3579	0.0421	0.0018	0.4	0.4394	0.0394	0.0016
0.4	0.4149	0.0149	0.0002	0.4	0.4054	0.0054	0.0000
0.4	0.3784	0.0216	0.0005	0.4	0.3523	0.0477	0.0023
0.4	0.3906	0.0094	0.0001	0.4	0.3669	0.0331	0.0011
0.4	0.3768	0.0232	0.0005	0.4	0.4342	0.0342	0.0012
0.4	0.397	0.003	0.0000	0.4	0.3504	0.0496	0.0025
0.4	0.3615	0.0385	0.0015	0.4	0.396	0.004	0.0000
0.4	0.3536	0.0464	0.0022	0.4	0.3586	0.0414	0.0017
0.4	0.3989	0.0011	0.0000	0.4	0.3985	0.0015	0.0000
0.4	0.3605	0.0395	0.0016	0.4	0.4179	0.0179	0.0003
0.4	0.3873	0.0127	0.0002	0.4	0.3795	0.0205	0.0004
0.4	0.3749	0.0251	0.0006	0.4	0.3767	0.0233	0.0005
0.4	0.3491	0.0509	0.0026	0.4	0.3526	0.0474	0.0022
0.4	0.3394	0.0606	0.0037	0.4	0.4135	0.0135	0.0002
0.4	0.4078	0.0078	0.0001	0.4	0.4564	0.0564	0.0032
0.4	0.4101	0.0101	0.0001	0.3	0.3256	0.0256	0.0007

Training				Validation			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.4	0.421	0.021	0.0004	0.4	0.3554	0.0446	0.0020
0.4	0.3942	0.0058	0.0000	0.4	0.3412	0.0588	0.0035
0.4	0.3662	0.0338	0.0011	0.4	0.4145	0.0145	0.0002
0.4	0.3919	0.0081	0.0001	0.4	0.5936	0.1936	0.0375
0.4	0.3708	0.0292	0.0009	0.4	0.4026	0.0026	0.0000
0.4	0.363	0.037	0.0014	0.4	0.3659	0.0341	0.0012
1	0.9801	0.0199	0.0004	0.4	0.3553	0.0447	0.0020
0.4	0.3758	0.0242	0.0006	0.4	0.4168	0.0168	0.0003
0.4	0.364	0.036	0.0013	0.4	0.3627	0.0373	0.0014
0	0.0704	0.0704	0.0050	0.4	0.4554	0.0554	0.0031
0	0.3842	0.3842	0.1476	0.4	0.3319	0.0681	0.0046
0	0.337	0.337	0.1136	0.4	0.3571	0.0429	0.0018
0.4	0.4059	0.0059	0.0000	0.4	0.3629	0.0371	0.0014
0.4	0.4056	0.0056	0.0000	0.4	0.425	0.025	0.0006
0.4	0.3578	0.0422	0.0018	0.4	0.3528	0.0472	0.0022
0.4	0.3813	0.0187	0.0003	0.4	0.3984	0.0016	0.0000
0.4	0.3365	0.0635	0.0040	0.4	0.4068	0.0068	0.0000
0.4	0.386	0.014	0.0002	0.4	0.4757	0.0757	0.0057
0.4	0.3931	0.0069	0.0000	0.4	0.3499	0.0501	0.0025
0.4	0.3901	0.0099	0.0001	0.4	0.3837	0.0163	0.0003
0.4	0.3851	0.0149	0.0002	0.4	0.3641	0.0359	0.0013
0.4	0.3481	0.0519	0.0027	0.4	0.7479	0.3479	0.1210
0.4	0.4239	0.0239	0.0006	0.4	0.3744	0.0256	0.0007
		Sum of Error	2.6249			Sum of Error	13.4042
		MSE	0.0079			MSE	0.0403

Result of Prediction with Neural Network (normalized value)

I Controller

Training				Validation				Testing			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.2	0.1939	0.0061	0.0000	0.9	0.9988	0.0988	0.0098	0.4	0.3113	0.0887	0.0079
1	0.9992	0.0008	0.0000	0.2	0.1012	0.0988	0.0098	0.1	0.1636	0.0636	0.0040
0.6	0.6044	0.0044	0.0000	0.1	0.4068	0.3068	0.0941	0	0.0325	0.0325	0.0011
0.5	0.5007	0.0007	0.0000	0.1	0.3548	0.2548	0.0649	0.6	0.5617	0.0383	0.0015
0.5	0.5037	0.0037	0.0000	0.2	0.266	0.066	0.0044	0	0.2111	0.2111	0.0446
0.5	0.4994	0.0006	0.0000	0.2	0.1351	0.0649	0.0042	0.1	0.0118	0.0882	0.0078
0.8	0.8006	0.0006	0.0000	0.2	0.2109	0.0109	0.0001	0.1	0.2504	0.1504	0.0226
0.1	0.1293	0.0293	0.0009	0.2	0.2369	0.0369	0.0014	0.1	0.1515	0.0515	0.0027
0.5	0.5001	1E-04	0.0000	0.1	0.3461	0.2461	0.0606	0.1	0.2021	0.1021	0.0104
0.2	0.1987	0.0013	0.0000	0.1	0.4873	0.3873	0.1500	0.1	0.3046	0.2046	0.0419
0.2	0.2026	0.0026	0.0000	0.1	0.1973	0.0973	0.0095	0.1	0.7708	0.6708	0.4500
0.2	0.2073	0.0073	0.0001	0.1	0.146	0.046	0.0021	0.1	0.1796	0.0796	0.0063
0.2	0.1039	0.0961	0.0092	0.1	0.3715	0.2715	0.0737	0.1	0.1515	0.0515	0.0027
0	0.1223	0.1223	0.0150	0.1	0.1039	0.0039	0.0000	0.4	0.3236	0.0764	0.0058
0.2	0.2266	0.0266	0.0007	0.1	0.1387	0.0387	0.0015	0.4	0.0717	0.3283	0.1078
0.2	0.1937	0.0063	0.0000	0.1	0.2205	0.1205	0.0145	0	0.0033	0.0033	0.0000
0	0.1688	0.1688	0.0285	0.1	0.1566	0.0566	0.0032	0	0.2997	0.2997	0.0898
0.5	0.504	0.004	0.0000	0.1	0.1759	0.0759	0.0058	0.1	0.1366	0.0366	0.0013
0.1	0.1837	0.0837	0.0070	0.4	0.7032	0.3032	0.0919	0.1	0.0846	0.0154	0.0002
0.2	0.2058	0.0058	0.0000	0.1	0.1318	0.0318	0.0010	0.1	0.1282	0.0282	0.0008
0.2	0.2055	0.0055	0.0000	0.1	0.4871	0.3871	0.1498	0.4	0.1787	0.2213	0.0490
0.2	0.0954	0.1046	0.0109	0.1	0.1077	0.0077	0.0001	0	0.0071	0.0071	0.0001
0.1	0.1166	0.0166	0.0003	0.1	0.1151	0.0151	0.0002	0.4	0.3079	0.0921	0.0085
0.6	0.6026	0.0026	0.0000	0.1	0.082	0.018	0.0003	0.2	0.1655	0.0345	0.0012
0.6	0.584	0.016	0.0003	0.1	0.1823	0.0823	0.0068	0.2	0.1416	0.0584	0.0034
0	0.0006	0.0006	0.0000	0.1	0.116	0.016	0.0003	0.2	0.2958	0.0958	0.0092
0.2	0.0706	0.1294	0.0167	0.1	0.1128	0.0128	0.0002	0.2	0.1256	0.0744	0.0055
0.2	0.1851	0.0149	0.0002	0.1	0.1822	0.0822	0.0068	0.2	0.1284	0.0716	0.0051
0.1	0.1006	0.0006	0.0000	0.3	0.2864	0.0136	0.0002	0.2	0.4459	0.2459	0.0605
0.1	0.094	0.006	0.0000	0.3	0.1464	0.1536	0.0236	0.2	0.182	0.018	0.0003
0.1	0.1529	0.0529	0.0028	0.3	0.2037	0.0963	0.0093	0.2	0.2816	0.0816	0.0067

Training				Validation				Testing			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.1	0.1101	0.0101	0.0001	0.1	0.1047	0.0047	0.0000	0.2	0.0902	0.1098	0.0121
0.1	0.1229	0.0229	0.0005	0.2	0.0882	0.1118	0.0125	0.2	0.1022	0.0978	0.0096
0.1	0.1024	0.0024	0.0000	0.1	0.0986	0.0014	0.0000	0.1	0.1188	0.0188	0.0004
0.1	0.1038	0.0038	0.0000	0.1	0.0656	0.0344	0.0012	0.1	0.2815	0.1815	0.0329
0.1	0.0736	0.0264	0.0007	0.1	0.1487	0.0487	0.0024	0.1	0.2685	0.1685	0.0284
0.1	0.0965	0.0035	0.0000	0.1	0.1759	0.0759	0.0058	0.1	0.2986	0.1986	0.0394
0.1	0.1011	0.0011	0.0000	0.1	0.1155	0.0155	0.0002	0.1	0.2418	0.1418	0.0201
0.1	0.1152	0.0152	0.0002	0.1	0.16	0.06	0.0036	0.1	0.0529	0.0471	0.0022
0.1	0.0961	0.0039	0.0000	0.2	0.1143	0.0857	0.0073	0.1	0.1516	0.0516	0.0027
0.1	0.2035	0.1035	0.0107	0.2	0.1414	0.0586	0.0034	0.3	0.3333	0.0333	0.0011
0.1	0.0983	0.0017	0.0000	0.2	0.1303	0.0697	0.0049	0.3	0.3031	0.0031	0.0000
0.1	0.0864	0.0136	0.0002	0.2	0.1368	0.0632	0.0040	0.3	0.2708	0.0292	0.0009
0.1	0.1321	0.0321	0.0010	0.3	0.2531	0.0469	0.0022	0.3	0.4732	0.1732	0.0300
0.1	0.0801	0.0199	0.0004	0.1	0.0486	0.0514	0.0026	0.3	0.0943	0.2057	0.0423
0.1	0.124	0.024	0.0006	0	0.1095	0.1095	0.0120	0.3	0.1988	0.1012	0.0102
0.1	0.0847	0.0153	0.0002	0	0.1929	0.1929	0.0372	0.3	0.2926	0.0074	0.0001
0.1	0.1512	0.0512	0.0026	0	0.1179	0.1179	0.0139	0.3	0.2082	0.0918	0.0084
0	0.1243	0.1243	0.0155	0	0.0593	0.0593	0.0035	0.2	0.095	0.105	0.0110
0	0.1043	0.1043	0.0109	0	0.1562	0.1562	0.0244	0.4	0.1901	0.2099	0.0441
0	0.1371	0.1371	0.0188	0.2	0.1671	0.0329	0.0011	0.1	0.1804	0.0804	0.0065
0.4	0.2303	0.1697	0.0288	0.2	0.0851	0.1149	0.0132	0.1	0.2583	0.1583	0.0251
0.4	0.403	0.003	0.0000	0.2	0.1154	0.0846	0.0072	0.1	0.4042	0.3042	0.0925
0.4	0.3898	0.0102	0.0001	0	0.0184	0.0184	0.0003	0.1	0.3553	0.2553	0.0652
0.4	0.1448	0.2552	0.0651	0.1	0.1778	0.0778	0.0061	0.1	0.1361	0.0361	0.0013
0.4	0.2414	0.1586	0.0252	0.1	0.0991	0.0009	0.0000	0.1	0.1266	0.0266	0.0007
0.4	0.2677	0.1323	0.0175	0.1	0.1416	0.0416	0.0017	0	0.1588	0.1588	0.0252
0	0.1534	0.1534	0.0235	0.1	0.121	0.021	0.0004	0	0.2387	0.2387	0.0570
0.1	0.1022	0.0022	0.0000	0.1	0.2402	0.1402	0.0197	0	0.2449	0.2449	0.0600
0	0.2008	0.2008	0.0403	0.1	0.2597	0.1597	0.0255	0	0.2643	0.2643	0.0699
0.2	0.1671	0.0329	0.0011	0.1	0.3677	0.2677	0.0717	0	0.1667	0.1667	0.0278
0.2	0.2141	0.0141	0.0002	0.1	0.1631	0.0631	0.0040	0	0.2335	0.2335	0.0545
0.2	0.2122	0.0122	0.0001	0.2	0.0904	0.1096	0.0120	0	0.0358	0.0358	0.0013
0.3	0.2042	0.0958	0.0092	0.2	0.2523	0.0523	0.0027	0	0.0255	0.0255	0.0007
0.3	0.3074	0.0074	0.0001	0.2	0.1781	0.0219	0.0005	0	0.0294	0.0294	0.0009
0.3	0.2246	0.0754	0.0057	0.2	0.232	0.032	0.0010	0	0.2569	0.2569	0.0660

Training				Validation				Testing			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.3	0.1535	0.1465	0.0215	0.2	0.0987	0.1013	0.0103	0	0.2453	0.2453	0.0602
0.3	0.1331	0.1669	0.0279	0.2	0.1723	0.0277	0.0008	0.1	0.367	0.267	0.0713
0.3	0.1423	0.1577	0.0249	0.1	0.0316	0.0684	0.0047	0.4	0.4321	0.0321	0.0010
0.3	0.2211	0.0789	0.0062	0.1	0.1198	0.0198	0.0004	0.1	0.1196	0.0196	0.0004
0.3	0.293	0.007	0.0000	0.1	0.1435	0.0435	0.0019	0.1	0.2681	0.1681	0.0283
0.1	0.0798	0.0202	0.0004	0.1	0.2658	0.1658	0.0275	0.6	0.2073	0.3927	0.1542
0.1	0.0916	0.0084	0.0001	0	0.0628	0.0628	0.0039	0.6	0.2599	0.3401	0.1157
0.1	0.2783	0.1783	0.0318	0	0.1358	0.1358	0.0184	0	0.0375	0.0375	0.0014
0.1	0.2466	0.1466	0.0215	0	0.1503	0.1503	0.0226	0	0.2012	0.2012	0.0405
0.1	0.0873	0.0127	0.0002	0	0.1337	0.1337	0.0179	0.3	0.7102	0.4102	0.1683
0.1	0.1426	0.0426	0.0018	0	0.2516	0.2516	0.0633	0.1	0.2057	0.1057	0.0112
0	0.183	0.183	0.0335	0.3	0.4011	0.1011	0.0102	0.1	0.1574	0.0574	0.0033
0.1	0.2329	0.1329	0.0177	0.3	0.1543	0.1457	0.0212	0.1	0.1542	0.0542	0.0029
0.1	0.0618	0.0382	0.0015	0.3	0.1981	0.1019	0.0104	0.1	0.4656	0.3656	0.1337
0.1	0.1081	0.0081	0.0001	0.3	0.1214	0.1786	0.0319	0.1	0.3501	0.2501	0.0626
0.1	0.1107	0.0107	0.0001	0.1	0.0735	0.0265	0.0007	0	0.0481	0.0481	0.0023
0.1	0.1447	0.0447	0.0020	0.1	0.3266	0.2266	0.0513	0.6	0.1187	0.4813	0.2316
0.1	0.1061	0.0061	0.0000	0.3	0.3963	0.0963	0.0093	0.5	0.3966	0.1034	0.0107
0.4	0.4008	0.0008	0.0000	0.3	0.1447	0.1553	0.0241	0.3	0.1983	0.1017	0.0103
0.4	0.1517	0.2483	0.0617	0.3	0.2686	0.0314	0.0010	0.4	0.3416	0.0584	0.0034
0.4	0.4244	0.0244	0.0006	0.3	0.1167	0.1833	0.0336	0.4	0.3098	0.0902	0.0081
0.4	0.3796	0.0204	0.0004	0.3	0.1741	0.1259	0.0159	0.4	0.2716	0.1284	0.0165
0.1	0.0896	0.0104	0.0001	0.3	0.137	0.163	0.0266	0.4	0.1143	0.2857	0.0816
0.1	0.0867	0.0133	0.0002	0.3	0.2379	0.0621	0.0039	0.4	0.313	0.087	0.0076
0.1	0.1319	0.0319	0.0010	0.2	0.1925	0.0075	0.0001	0	0.0147	0.0147	0.0002
0.1	0.1132	0.0132	0.0002	0	0.0664	0.0664	0.0044	0.6	0.3751	0.2249	0.0506
0.1	0.108	0.008	0.0001	0.3	0.1055	0.1945	0.0378	0.2	0.2902	0.0902	0.0081
0	0.0643	0.0643	0.0041	0.3	0.2841	0.0159	0.0003	0.2	0.4799	0.2799	0.0783
0	0.1661	0.1661	0.0276	0.3	0.1657	0.1343	0.0180	0.4	0.7063	0.3063	0.0938
0	0.3005	0.3005	0.0903	0.3	0.1001	0.1999	0.0400	0.4	0.3174	0.0826	0.0068
0.1	0.0945	0.0055	0.0000	0.3	0.1651	0.1349	0.0182	0.4	0.1777	0.2223	0.0494
0.1	0.0727	0.0273	0.0007	0.3	0.1499	0.1501	0.0225	0.4	0.1994	0.2006	0.0402
0.1	0.0881	0.0119	0.0001	0.3	0.1844	0.1156	0.0134	0.4	0.577	0.177	0.0313
0.1	0.1846	0.0846	0.0072	0.3	0.1623	0.1377	0.0190	0.4	0.2067	0.1933	0.0374
0.2	0.2096	0.0096	0.0001	0.3	0.2346	0.0654	0.0043	0.4	0.4645	0.0645	0.0042

Training				Validation				Testing			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.2	0.3575	0.1575	0.0248	0.3	0.1136	0.1864	0.0347	0.3	0.4011	0.1011	0.0102
0.2	0.1	0.1	0.0100	0.1	0.1319	0.0319	0.0010	0.4	0.4687	0.0687	0.0047
0.2	0.1327	0.0673	0.0045	0.1	0.1333	0.0333	0.0011	0	0.0128	0.0128	0.0002
0.1	0.1026	0.0026	0.0000	0.1	0.1744	0.0744	0.0055	0.2	0.2384	0.0384	0.0015
0.1	0.1076	0.0076	0.0001	0.1	0.392	0.292	0.0853	0.4	0.3613	0.0387	0.0015
0.1	0.2123	0.1123	0.0126	0.1	0.2986	0.1986	0.0394			Sum of Error	3.4542
0.1	0.1631	0.0631	0.0040	0.1	0.1712	0.0712	0.0051			MSE	0.0326
0.1	0.266	0.166	0.0276	0.1	0.0926	0.0074	0.0001				
0.1	0.0695	0.0305	0.0009	0.1	0.3887	0.2887	0.0833				
0.1	0.2941	0.1941	0.0377	0.2	0.2093	0.0093	0.0001				
0.1	0.1843	0.0843	0.0071	0.2	0.1526	0.0474	0.0022				
0.5	0.4722	0.0278	0.0008	0.2	0.1735	0.0265	0.0007				
0	0.0825	0.0825	0.0068	0.1	0.0325	0.0675	0.0046				
0	0	0	0.0000	0.1	0.276	0.176	0.0310				
0	0.1717	0.1717	0.0295	0.1	0.1466	0.0466	0.0022				
0.1	0.1723	0.0723	0.0052	0.1	0.1765	0.0765	0.0059				
0.1	0.1588	0.0588	0.0035	0.1	0.1415	0.0415	0.0017				
0.2	0.2049	0.0049	0.0000	0.1	0.3134	0.2134	0.0455				
0.2	0.2066	0.0066	0.0000	0.1	0.1551	0.0551	0.0030				
0.4	0.3957	0.0043	0.0000	0.2	0.2662	0.0662	0.0044				
0.3	0.3102	0.0102	0.0001	0.2	0.048	0.152	0.0231				
0	0.0421	0.0421	0.0018	0.2	0.1571	0.0429	0.0018				
0.2	0.2172	0.0172	0.0003	0.1	0.0982	0.0018	0.0000				
0.3	0.3511	0.0511	0.0026	0.1	0.1251	0.0251	0.0006				
0.3	0.2434	0.0566	0.0032	0.1	0.1023	0.0023	0.0000				
0.3	0.1395	0.1605	0.0258	0.1	0.2976	0.1976	0.0390				
0.3	0.1832	0.1168	0.0136	0.3	0.3056	0.0056	0.0000				
0.3	0.2983	0.0017	0.0000	0.3	0.2897	0.0103	0.0001				
0.2	0.1771	0.0229	0.0005	0.3	0.21	0.09	0.0081				
0.1	0.0754	0.0246	0.0006	0.3	0.1488	0.1512	0.0229				
0.1	0.0869	0.0131	0.0002	0	0.0788	0.0788	0.0062				
0.1	0.1274	0.0274	0.0008	0	0.0959	0.0959	0.0092				
0.1	0.1159	0.0159	0.0003	0	0.097	0.097	0.0094				
0.1	0.165	0.065	0.0042	0	0.1386	0.1386	0.0192				
0.1	0.0127	0.0873	0.0076	0.1	0.0426	0.0574	0.0033				

Training				Validation			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.2	0.2149	0.0149	0.0002	0.2	0.2395	0.0395	0.0016
0.3	0.3022	0.0022	0.0000	0.2	0.3137	0.1137	0.0129
0.3	0.1765	0.1235	0.0153	0.3	0.1001	0.1999	0.0400
0.3	0.3111	0.0111	0.0001	0.3	0.1259	0.1741	0.0303
0.3	0.332	0.032	0.0010	0.3	0.244	0.056	0.0031
0.3	0.2407	0.0593	0.0035	0.4	0.1474	0.2526	0.0638
0.3	0.1796	0.1204	0.0145	0.4	0.1338	0.2662	0.0709
0.4	0.3372	0.0628	0.0039	0.4	0.3695	0.0305	0.0009
0.3	0.2382	0.0618	0.0038	0.3	0.2212	0.0788	0.0062
0.3	0.1698	0.1302	0.0170	0.3	0.1785	0.1215	0.0148
0.3	0.346	0.046	0.0021	0.4	0.3673	0.0327	0.0011
0.3	0.1747	0.1253	0.0157	0.4	0.496	0.096	0.0092
0.3	0.3168	0.0168	0.0003	0	0.0434	0.0434	0.0019
0.3	0.2881	0.0119	0.0001	0	0.1787	0.1787	0.0319
0.2	0.195	0.005	0.0000	0.3	0.2989	0.0011	0.0000
0.2	0.222	0.022	0.0005	0	0.1247	0.1247	0.0156
0.2	0.2748	0.0748	0.0056	0	0.2468	0.2468	0.0609
0.2	0.1838	0.0162	0.0003	0.1	0.1482	0.0482	0.0023
0	0.0045	0.0045	0.0000	0.1	0.2823	0.1823	0.0332
0	0.1724	0.1724	0.0297	0	0.0416	0.0416	0.0017
0	0.1655	0.1655	0.0274	0	0.0355	0.0355	0.0013
0.1	0.3401	0.2401	0.0576	0	0.1771	0.1771	0.0314
0.3	0.3336	0.0336	0.0011	0.2	0.2433	0.0433	0.0019
0.3	0.2107	0.0893	0.0080	0.1	0.1462	0.0462	0.0021
0.2	0.2472	0.0472	0.0022	0.1	0.1645	0.0645	0.0042
0.2	0.1737	0.0263	0.0007	0.1	0.2891	0.1891	0.0358
0.2	0.4134	0.2134	0.0455	0.3	0.3683	0.0683	0.0047
0.2	0.1124	0.0876	0.0077	0.2	0.3767	0.1767	0.0312
0.5	0.4835	0.0165	0.0003	0.2	0.1833	0.0167	0.0003
0.5	0.4159	0.0841	0.0071	0.2	0.1931	0.0069	0.0000
0.5	0.5224	0.0224	0.0005	0.1	0.1497	0.0497	0.0025
0.5	0.3261	0.1739	0.0302	0.3	0.3097	0.0097	0.0001
0.5	0.3134	0.1866	0.0348	0.3	0.0774	0.2226	0.0496
0.5	0.5172	0.0172	0.0003	0.3	0.3631	0.0631	0.0040
0.5	0.3526	0.1474	0.0217	0.3	0.0738	0.2262	0.0512

Training				Validation			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.1	0.0798	0.0202	0.0004	0.2	0.2594	0.0594	0.0035
0.3	0.3105	0.0105	0.0001	0.2	0.3604	0.1604	0.0257
0.3	0.2407	0.0593	0.0035	0.3	0.2347	0.0653	0.0043
0.3	0.2877	0.0123	0.0002	0.1	0.089	0.011	0.0001
0.3	0.254	0.046	0.0021	0.1	0.1294	0.0294	0.0009
0.3	0.3	0	0.0000	0.1	0.3836	0.2836	0.0804
0.1	0.1011	0.0011	0.0000	0.1	0.1775	0.0775	0.0060
0.1	0.1759	0.0759	0.0058	0.1	0.3358	0.2358	0.0556
0.4	0.3444	0.0556	0.0031	0.5	0.425	0.075	0.0056
0.4	0.4004	0.0004	0.0000	0.5	0.1907	0.3093	0.0957
0.2	0.2049	0.0049	0.0000	0.5	0.3138	0.1862	0.0347
0.2	0.1863	0.0137	0.0002	0.5	0.1106	0.3894	0.1516
0.2	0.3062	0.1062	0.0113	0.4	0.4352	0.0352	0.0012
0	0.1361	0.1361	0.0185	0.4	0.3712	0.0288	0.0008
0	0.0048	0.0048	0.0000	0.4	0.1669	0.2331	0.0543
0	0.0852	0.0852	0.0073	0.4	0.1855	0.2145	0.0460
0.5	0.4059	0.0941	0.0089	0.1	0.0723	0.0277	0.0008
0.5	0.1858	0.3142	0.0987	0.4	0.4234	0.0234	0.0005
0.5	0.3061	0.1939	0.0376	0.1	0.2038	0.1038	0.0108
0	0.0225	0.0225	0.0005	0.1	0.1714	0.0714	0.0051
0.1	0.1086	0.0086	0.0001	0	0.0007	0.0007	0.0000
0.1	0.1758	0.0758	0.0057	0	0.2502	0.2502	0.0626
0.1	0.1665	0.0665	0.0044	0.2	0.2612	0.0612	0.0037
0.1	0.3565	0.2565	0.0658	0.2	0.0631	0.1369	0.0187
0.2	0.2084	0.0084	0.0001	0.2	0.1915	0.0085	0.0001
0.2	0.2632	0.0632	0.0040	0.2	0.3548	0.1548	0.0240
0.2	0.3202	0.1202	0.0144	0.2	0.1653	0.0347	0.0012
0.2	0.3506	0.1506	0.0227	0.2	0.1672	0.0328	0.0011
0	0.0166	0.0166	0.0003	0.2	0.1778	0.0222	0.0005
0.4	0.3986	0.0014	0.0000	0	0.0087	0.0087	0.0001
0.4	0.3509	0.0491	0.0024	0	0.2037	0.2037	0.0415
0.4	0.3892	0.0108	0.0001	0	0.2246	0.2246	0.0504
0.4	0.3076	0.0924	0.0085	0	0.2728	0.2728	0.0744
0.4	0.3111	0.0889	0.0079	0	0.1816	0.1816	0.0330
0.4	0.2879	0.1121	0.0126	0	0.1837	0.1837	0.0337

Training				Validation			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.3	0.2447	0.0553	0.0031	0	0.2891	0.2891	0.0836
0.6	0.6195	0.0195	0.0004	0	0.1823	0.1823	0.0332
0.6	0.3347	0.2653	0.0704	0	0.1111	0.1111	0.0123
0	0.1864	0.1864	0.0347	0	0.0957	0.0957	0.0092
0.5	0.5072	0.0072	0.0001	0	0.0882	0.0882	0.0078
0.2	0.2394	0.0394	0.0016	0	0.336	0.336	0.1129
0.4	0.39	0.01	0.0001	0	0.3672	0.3672	0.1348
0.4	0.3296	0.0704	0.0050	0.2	0.1998	0.0002	0.0000
0.4	0.2642	0.1358	0.0184	0.2	0.3342	0.1342	0.0180
0.4	0.3195	0.0805	0.0065	0.2	0.1868	0.0132	0.0002
0.4	0.4051	0.0051	0.0000	0.2	0.1999	0.0001	0.0000
0.4	0.2983	0.1017	0.0103	0.2	0.3173	0.1173	0.0138
0.4	0.3246	0.0754	0.0057	0.2	0.0868	0.1132	0.0128
0.6	0.5299	0.0701	0.0049	0.4	0.387	0.013	0.0002
0.6	0.3576	0.2424	0.0588	0.3	0.6837	0.3837	0.1472
0.5	0.5444	0.0444	0.0020	0.3	0.3277	0.0277	0.0008
0.5	0.4736	0.0264	0.0007	0.3	0.2399	0.0601	0.0036
0.5	0.3482	0.1518	0.0230	0.3	0.3552	0.0552	0.0030
0.4	0.369	0.031	0.0010	0.1	0.0653	0.0347	0.0012
0.4	0.3192	0.0808	0.0065	0.1	0.218	0.118	0.0139
0.3	0.2994	0.0006	0.0000	0.1	0.3372	0.2372	0.0563
0.3	0.1962	0.1038	0.0108	0.1	0.3399	0.2399	0.0576
0	0	0	0.0000	0	0.0313	0.0313	0.0010
0	0.02	0.02	0.0004	0	0.3587	0.3587	0.1287
0	0.3314	0.3314	0.1098	0	0.2833	0.2833	0.0803
0.5	0.3444	0.1556	0.0242	0	0.0116	0.0116	0.0001
0.1	0.1027	0.0027	0.0000	0	0.2126	0.2126	0.0452
0	0.0014	0.0014	0.0000	0.1	0.157	0.057	0.0032
0	0.1358	0.1358	0.0184	0.2	0.2587	0.0587	0.0034
0.1	0.0821	0.0179	0.0003	0.5	0.6138	0.1138	0.0130
0.1	0.065	0.035	0.0012	0.1	0.0581	0.0419	0.0018
0.1	0.1956	0.0956	0.0091	0.4	0.5814	0.1814	0.0329
0.5	0.5573	0.0573	0.0033	0.4	0.1632	0.2368	0.0561
0.5	0.2563	0.2437	0.0594	0.2	0.226	0.026	0.0007
0	0.0437	0.0437	0.0019	0.4	0.539	0.139	0.0193

Training				Validation			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.4	0.4024	0.0024	0.0000	0.4	0.6049	0.2049	0.0420
0.3	0.3253	0.0253	0.0006	0.4	0.2471	0.1529	0.0234
0.2	0.2531	0.0531	0.0028	0	0.0329	0.0329	0.0011
0.4	0.399	0.001	0.0000	0	0.0202	0.0202	0.0004
0.4	0.2996	0.1004	0.0101	0	0.0925	0.0925	0.0086
0.1	0.0784	0.0216	0.0005	0.4	0.2481	0.1519	0.0231
0.1	0.0894	0.0106	0.0001	0.6	0.7777	0.1777	0.0316
0.5	0.5242	0.0242	0.0006	0.6	0.718	0.118	0.0139
0.5	0.2916	0.2084	0.0434	0.6	0.3556	0.2444	0.0597
0.4	0.3578	0.0422	0.0018	0.6	0.3705	0.2295	0.0527
0.2	0.1829	0.0171	0.0003	0.3	0.3498	0.0498	0.0025
0.2	0.1971	0.0029	0.0000	0.3	0.064	0.236	0.0557
0.5	0.4594	0.0406	0.0016	0.3	0.3127	0.0127	0.0002
0.3	0.3004	0.0004	0.0000	0.1	0.1071	0.0071	0.0001
0.3	0.3456	0.0456	0.0021	0.5	0.5006	0.0006	0.0000
0.5	0.5061	0.0061	0.0000	0.5	0.2905	0.2095	0.0439
0.2	0.1895	0.0105	0.0001	0.5	0.3642	0.1358	0.0184
0.1	0.0879	0.0121	0.0001	0.5	0.3615	0.1385	0.0192
0	0.0124	0.0124	0.0002	0.5	0.2924	0.2076	0.0431
0.2	0.1973	0.0027	0.0000	0.5	0.201	0.299	0.0894
0.2	0.3171	0.1171	0.0137	0.5	0.3102	0.1898	0.0360
0	0.0098	0.0098	0.0001	0.2	0.3003	0.1003	0.0101
0	0.1341	0.1341	0.0180	0.2	0.2983	0.0983	0.0097
0	0.1577	0.1577	0.0249	0.3	0.3114	0.0114	0.0001
0	0.0867	0.0867	0.0075	0.6	0.4609	0.1391	0.0193
0	0.075	0.075	0.0056	0	0.3129	0.3129	0.0979
0	0.033	0.033	0.0011	0	0.1713	0.1713	0.0293
0	0.0477	0.0477	0.0023	0.5	0.6016	0.1016	0.0103
0	0.0725	0.0725	0.0053	0.5	0.067	0.433	0.1875
0.3	0.2503	0.0497	0.0025	0	0.0445	0.0445	0.0020
0.3	0.1767	0.1233	0.0152	0.5	0.4331	0.0669	0.0045
0.3	0.2804	0.0196	0.0004	0.5	0.3139	0.1861	0.0346
0.3	0.3139	0.0139	0.0002	0.1	0.0936	0.0064	0.0000
0.2	0.2044	0.0044	0.0000	0.1	0.0913	0.0087	0.0001
0.2	0.0508	0.1492	0.0223	0.1	0.0552	0.0448	0.0020

Training				Validation			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.3	0.3125	0.0125	0.0002	0.2	0.2421	0.0421	0.0018
0	0.011	0.011	0.0001	0.3	0.0698	0.2302	0.0530
0.2	0.1881	0.0119	0.0001	0.7	0.279	0.421	0.1772
0.2	0.3585	0.1585	0.0251	0.7	0.4874	0.2126	0.0452
0.2	0.3019	0.1019	0.0104	0.7	0.2955	0.4045	0.1636
0.5	0.516	0.016	0.0003	0.5	0.5558	0.0558	0.0031
0.5	0.326	0.174	0.0303	0.5	0.3098	0.1902	0.0362
0	0	0	0.0000	0.5	0.3587	0.1413	0.0200
0.6	0.609	0.009	0.0001	0.6	0.533	0.067	0.0045
0.6	0.3958	0.2042	0.0417	0.5	0.7203	0.2203	0.0485
0.6	0.5769	0.0231	0.0005	0.5	0.1968	0.3032	0.0919
0.6	0.3277	0.2723	0.0741	0.4	0.4658	0.0658	0.0043
0.3	0.2959	0.0041	0.0000	0.4	0.1069	0.2931	0.0859
0.1	0.1432	0.0432	0.0019	0.3	0.278	0.022	0.0005
0.1	0.349	0.249	0.0620	0.6	0.6648	0.0648	0.0042
0.1	0.3115	0.2115	0.0447	0.3	0.2508	0.0492	0.0024
0.1	0.2157	0.1157	0.0134	0.3	0.0518	0.2482	0.0616
0.5	0.5232	0.0232	0.0005	0.3	0.3481	0.0481	0.0023
0.6	0.6223	0.0223	0.0005	0.1	0.1493	0.0493	0.0024
0.6	0.4228	0.1772	0.0314	0.1	0.337	0.237	0.0562
0.3	0.2869	0.0131	0.0002	0.7	0.6056	0.0944	0.0089
0.1	0.1052	0.0052	0.0000	0.7	0.1317	0.5683	0.3230
0.1	0.3215	0.2215	0.0491	0.1	0.0111	0.0889	0.0079
0.4	0.3894	0.0106	0.0001	0.1	0.4797	0.3797	0.1442
0.4	0.2584	0.1416	0.0201	0.4	0.3838	0.0162	0.0003
0.6	0.5171	0.0829	0.0069	0.7	0.4423	0.2577	0.0664
0.1	0.0958	0.0042	0.0000	0.6	0.4015	0.1985	0.0394
0.6	0.564	0.036	0.0013	0.4	0.6795	0.2795	0.0781
0.6	0.4129	0.1871	0.0350	0.5	0.5869	0.0869	0.0076
0.6	0.4077	0.1923	0.0370	0.3	0.3331	0.0331	0.0011
0.6	0.4495	0.1505	0.0227	0.6	0.6234	0.0234	0.0005
0.7	0.6871	0.0129	0.0002	0.6	0.4729	0.1271	0.0162
0.7	0.3024	0.3976	0.1581	0.3	0.1486	0.1514	0.0229
0	0.1342	0.1342	0.0180	0.3	0.0081	0.2919	0.0852
0.2	0.2306	0.0306	0.0009	0.7	0.5586	0.1414	0.0200

Training				Validation			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.2	0.1903	0.0097	0.0001	0.6	0.4723	0.1277	0.0163
0.2	0.3745	0.1745	0.0305	0.6	0.073	0.527	0.2777
0.2	0.2952	0.0952	0.0091	0	0.0272	0.0272	0.0007
0.2	0.1706	0.0294	0.0009	0	0.3251	0.3251	0.1057
0.6	0.5335	0.0665	0.0044	0	0.3297	0.3297	0.1087
0	0.0229	0.0229	0.0005	0	0.4014	0.4014	0.1611
0	0.3542	0.3542	0.1255	0.4	0.6725	0.2725	0.0743
0.1	0.1694	0.0694	0.0048	0.4	0.3001	0.0999	0.0100
0	0.0008	0.0008	0.0000	0.6	0.0391	0.5609	0.3146
0	0.0596	0.0596	0.0036	0.7	0.6427	0.0573	0.0033
0	0.1416	0.1416	0.0201	0.7	0.3342	0.3658	0.1338
0.1	0.102	0.002	0.0000	0.4	0.2145	0.1855	0.0344
0.1	0.3165	0.2165	0.0469	0.5	0.4307	0.0693	0.0048
0.1	0.2319	0.1319	0.0174	0.5	0.0709	0.4291	0.1841
0.4	0.4268	0.0268	0.0007	0.2	0.1684	0.0316	0.0010
0.6	0.6296	0.0296	0.0009	0.2	0.322	0.122	0.0149
0.2	0.1501	0.0499	0.0025	0.5	0.1448	0.3552	0.1262
0.3	0.3189	0.0189	0.0004	0.6	0.7386	0.1386	0.0192
0.4	0.4278	0.0278	0.0008	0.6	0.3565	0.2435	0.0593
0.4	0.3198	0.0802	0.0064	0.3	0.1982	0.1018	0.0104
0.6	0.5977	0.0023	0.0000	0	0.0105	0.0105	0.0001
0.2	0.2036	0.0036	0.0000	0.1	0.2954	0.1954	0.0382
		Sum of Error	3.3377			Sum of Error	9.2142
		MSE	0.0100			MSE	0.0277

Result of Prediction with Neural Network (normalized value)

D Controller

Training				Validation				Testing			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.5	0.5002	0.0002	0.0000	0.5	0.3576	0.1424	0.0203	0.5	0.3092	0.1908	0.0364
0.5	0.5152	0.0152	0.0002	0.5	0.6213	0.1213	0.0147	0.5	0.5285	0.0285	0.0008
0.5	0.5005	0.0005	0.0000	0.5	0.0759	0.4241	0.1799	1	0.6416	0.3584	0.1285
0.5	0.5081	0.0081	0.0001	0.5	0.0382	0.4618	0.2133	0.5	0.1339	0.3661	0.1340
0.5	0.4864	0.0136	0.0002	0.5	0.4923	0.0077	0.0001	0.5	0.5015	0.0015	0.0000
0	0.0454	0.0454	0.0021	0.5	0.9872	0.4872	0.2374	0.5	0.114	0.386	0.1490
0.5	0.5001	1E-04	0.0000	0.5	0.5202	0.0202	0.0004	0.5	0.1179	0.3821	0.1460
0.5	0.4979	0.0021	0.0000	0	0.0488	0.0488	0.0024	0.5	0.545	0.045	0.0020
0.5	0.4913	0.0087	0.0001	0.5	0.2726	0.2274	0.0517	0.5	0.0443	0.4557	0.2077
0.5	0.5005	0.0005	0.0000	0.5	0.9795	0.4795	0.2299	0.5	0.4802	0.0198	0.0004
0.5	0.4935	0.0065	0.0000	0.6	0.0773	0.5227	0.2732	0.5	0.1815	0.3185	0.1014
0	0.0588	0.0588	0.0035	0.5	0.209	0.291	0.0847	0.5	0.534	0.034	0.0012
0.5	0.5203	0.0203	0.0004	0.5	0.3961	0.1039	0.0108	0.5	0.2552	0.2448	0.0599
0.8	0.6738	0.1262	0.0159	0.5	0.5203	0.0203	0.0004	0.5	0.436	0.064	0.0041
0.5	0.4682	0.0318	0.0010	0.5	0.6265	0.1265	0.0160	0.5	0.003	0.497	0.2470
0.5	0.4997	0.0003	0.0000	0.5	0.5554	0.0554	0.0031	0.5	0.8321	0.3321	0.1103
0.6	0.381	0.219	0.0480	0.5	0.592	0.092	0.0085	0.5	0.5543	0.0543	0.0029
0.5	0.5085	0.0085	0.0001	0.5	0.4663	0.0337	0.0011	0.5	0.509	0.009	0.0001
0.5	0.4878	0.0122	0.0001	0.5	0.0378	0.4622	0.2136	0.5	0.5147	0.0147	0.0002
0.5	0.5074	0.0074	0.0001	0.5	0.2337	0.2663	0.0709	0.5	0.4093	0.0907	0.0082
0.5	0.4972	0.0028	0.0000	0.5	0.0155	0.4845	0.2347	0.5	0.4946	0.0054	0.0000
0	0.19	0.19	0.0361	0	0.6911	0.6911	0.4776	0.5	0.4471	0.0529	0.0028
0.5	0.5005	0.0005	0.0000	0.5	0.5866	0.0866	0.0075	0.5	0.4958	0.0042	0.0000
0.5	0.4974	0.0026	0.0000	0.5	0.3167	0.1833	0.0336	0.5	0.4615	0.0385	0.0015
0.5	0.4921	0.0079	0.0001	0	0.0715	0.0715	0.0051	0.5	0.4911	0.0089	0.0001
0.5	0.5067	0.0067	0.0000	0.5	0.2726	0.2274	0.0517	0.5	0.2778	0.2222	0.0494
0.5	0.5142	0.0142	0.0002	0.5	0.1211	0.3789	0.1436	0.5	0.4967	0.0033	0.0000
0	0.0976	0.0976	0.0095	0.5	0.0553	0.4447	0.1978	0.5	0.413	0.087	0.0076
0.5	0.4991	0.0009	0.0000	0.5	0.6044	0.1044	0.0109	0.5	0.5013	0.0013	0.0000
0.5	0.1252	0.3748	0.1405	0	0.1636	0.1636	0.0268	0.5	0.4289	0.0711	0.0051
0.5	0.5017	0.0017	0.0000	0.5	0.1276	0.3724	0.1387	0.5	0.5059	0.0059	0.0000

Training				Validation				Testing			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0	0.0499	0.0499	0.0025	0.5	0.3363	0.1637	0.0268	0.5	0.0177	0.4823	0.2326
0.5	0.5147	0.0147	0.0002	0.5	0.0082	0.4918	0.2419	0.5	0.5036	0.0036	0.0000
0	0.0063	0.0063	0.0000	0.5	0.4093	0.0907	0.0082	0.5	0.5719	0.0719	0.0052
0.5	0.4987	0.0013	0.0000	0.5	0.9977	0.4977	0.2477	0.5	0.474	0.026	0.0007
0.5	0.5067	0.0067	0.0000	0.5	0.0506	0.4494	0.2020	0	0.291	0.291	0.0847
0.5	0.4835	0.0165	0.0003	0.5	0.4876	0.0124	0.0002	0.5	0.5566	0.0566	0.0032
0.5	0.4047	0.0953	0.0091	0.5	0.6572	0.1572	0.0247	0.5	0.5279	0.0279	0.0008
0.5	0.6704	0.1704	0.0290	0.5	0.5055	0.0055	0.0000	0.5	0.5087	0.0087	0.0001
0	0.0056	0.0056	0.0000	0.5	0.5225	0.0225	0.0005	0.5	0.5468	0.0468	0.0022
0.5	0.4634	0.0366	0.0013	0	0.0576	0.0576	0.0033	0.5	0.4069	0.0931	0.0087
0	0.01	0.01	0.0001	0.5	0.337	0.163	0.0266	0.5	0.5583	0.0583	0.0034
0.5	0.5385	0.0385	0.0015	0	0.0487	0.0487	0.0024	0.5	0.4701	0.0299	0.0009
0	0.053	0.053	0.0028	0.5	0.5253	0.0253	0.0006	0.5	0.6375	0.1375	0.0189
0.5	0.505	0.005	0.0000	0.5	0.9595	0.4595	0.2111	0.5	0.193	0.307	0.0942
0	0.0081	0.0081	0.0001	0.5	0.5973	0.0973	0.0095	0.5	0.4839	0.0161	0.0003
0.5	0.4745	0.0255	0.0007	0	0.1871	0.1871	0.0350	0.5	0.4391	0.0609	0.0037
0.5	0.4996	0.0004	0.0000	0	0.3788	0.3788	0.1435	0.5	0.3256	0.1744	0.0304
0	0.0621	0.0621	0.0039	0	0.4734	0.4734	0.2241	0.5	0.5347	0.0347	0.0012
0	0.239	0.239	0.0571	0	0.1902	0.1902	0.0362	0.5	0.4394	0.0606	0.0037
0	0.1262	0.1262	0.0159	0.5	0.5026	0.0026	0.0000	0.5	0.4509	0.0491	0.0024
0.5	0.4814	0.0186	0.0003	0.5	0.5888	0.0888	0.0079	0.5	0.5118	0.0118	0.0001
0.5	0.4707	0.0293	0.0009	0.5	0.1648	0.3352	0.1124	0.5	0.4467	0.0533	0.0028
0.5	0.5499	0.0499	0.0025	0.5	0.4804	0.0196	0.0004	0.5	0.4973	0.0027	0.0000
0	0.3089	0.3089	0.0954	0.5	0.1806	0.3194	0.1020	0.5	0.4525	0.0475	0.0023
0.5	0.4648	0.0352	0.0012	0.5	0.5046	0.0046	0.0000	0.5	0.317	0.183	0.0335
0	0.1178	0.1178	0.0139	0.5	0.1911	0.3089	0.0954	0	0.1881	0.1881	0.0354
0.5	0.3922	0.1078	0.0116	0.5	0.0727	0.4273	0.1826	0	0.5244	0.5244	0.2750
0.5	0.4435	0.0565	0.0032	0.5	0.4726	0.0274	0.0008	0	0.4755	0.4755	0.2261
0.5	0.5182	0.0182	0.0003	0.5	0.5399	0.0399	0.0016	0	0.4991	0.4991	0.2491
0.5	0.5026	0.0026	0.0000	0.5	0.5323	0.0323	0.0010	0	0.3087	0.3087	0.0953
0.5	0.5001	1E-04	0.0000	0.5	0.5708	0.0708	0.0050	0	0.486	0.486	0.2362
0.5	0.5037	0.0037	0.0000	0.5	0.4713	0.0287	0.0008	0.5	0.3576	0.1424	0.0203
0.5	0.4108	0.0892	0.0080	0.5	0.5583	0.0583	0.0034	0.5	0.5321	0.0321	0.0010
0.5	0.4983	0.0017	0.0000	0.5	0.5077	0.0077	0.0001	0.5	0.4892	0.0108	0.0001
0.5	0.4954	0.0046	0.0000	0.5	0.2065	0.2935	0.0861	0	0.534	0.534	0.2852

Training				Validation				Testing			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.5	0.5163	0.0163	0.0003	0.5	0.492	0.008	0.0001	0.5	0.512	0.012	0.0001
0	0.1572	0.1572	0.0247	0.5	0.5279	0.0279	0.0008	0.5	0.443	0.057	0.0032
0	0.0395	0.0395	0.0016	0.5	0.9934	0.4934	0.2434	0.5	0.4649	0.0351	0.0012
0.5	0.5138	0.0138	0.0002	0.5	0.511	0.011	0.0001	0.5	0.4921	0.0079	0.0001
0.5	0.5063	0.0063	0.0000	0.5	0.6525	0.1525	0.0233	0	0.6169	0.6169	0.3806
0.5	0.5108	0.0108	0.0001	0.5	0.5285	0.0285	0.0008	0.5	0.3317	0.1683	0.0283
0.5	0.5007	0.0007	0.0000	0	0.0702	0.0702	0.0049	0.5	0.5364	0.0364	0.0013
0.5	0.5673	0.0673	0.0045	0	0.5159	0.5159	0.2662	0.8	0.6283	0.1717	0.0295
0.5	0.4779	0.0221	0.0005	0	0.0908	0.0908	0.0082	0.5	0.5293	0.0293	0.0009
0.5	0.5211	0.0211	0.0004	0	0.3666	0.3666	0.1344	0.5	0.5006	0.0006	0.0000
0.5	0.5084	0.0084	0.0001	0	0.5215	0.5215	0.2720	0.5	0.3702	0.1298	0.0168
0.5	0.4663	0.0337	0.0011	0.5	0.4481	0.0519	0.0027	0.5	0.4789	0.0211	0.0004
0.5	0.3195	0.1805	0.0326	0	0.3893	0.3893	0.1516	0.5	0.308	0.192	0.0369
0.5	0.4728	0.0272	0.0007	0.5	0.4422	0.0578	0.0033	0.5	0.4979	0.0021	0.0000
0.5	0.523	0.023	0.0005	0	0.0737	0.0737	0.0054	0.5	0.4623	0.0377	0.0014
0	0.0585	0.0585	0.0034	0.5	0.5264	0.0264	0.0007	0.5	0.613	0.113	0.0128
0	0.2875	0.2875	0.0827	0.5	0.5173	0.0173	0.0003	0.5	0.3354	0.1646	0.0271
0.5	0.3679	0.1321	0.0175	0.5	0.4748	0.0252	0.0006	0.5	0.066	0.434	0.1884
0.5	0.4427	0.0573	0.0033	0.5	0.1842	0.3158	0.0997	0.5	0.5889	0.0889	0.0079
0	0.0707	0.0707	0.0050	0.5	0.5077	0.0077	0.0001	0.5	0.5767	0.0767	0.0059
0.5	0.4619	0.0381	0.0015	0	0.0775	0.0775	0.0060	0.5	0.4031	0.0969	0.0094
0.5	0.4603	0.0397	0.0016	0.5	0.4045	0.0955	0.0091	0.5	0.4842	0.0158	0.0002
0.5	0.5046	0.0046	0.0000	0.5	0.6721	0.1721	0.0296	0.5	0.2846	0.2154	0.0464
0.5	0.5054	0.0054	0.0000	0.5	0.5123	0.0123	0.0002	0.5	0.3759	0.1241	0.0154
0.5	0.5991	0.0991	0.0098	0.5	0.4763	0.0237	0.0006	0.5	0.6063	0.1063	0.0113
0.5	0.5002	0.0002	0.0000	0.5	0.4989	0.0011	0.0000	0.5	0.4856	0.0144	0.0002
0	0.0028	0.0028	0.0000	0.5	0.4785	0.0215	0.0005	0.5	0.4193	0.0807	0.0065
0	0.1412	0.1412	0.0199	0.5	0.5016	0.0016	0.0000	0.5	0.5046	0.0046	0.0000
0	0.1744	0.1744	0.0304	0.5	0.6308	0.1308	0.0171	0.5	0.5391	0.0391	0.0015
0	0.4742	0.4742	0.2249	0.5	0.4853	0.0147	0.0002	0.5	0.4685	0.0315	0.0010
0.5	0.5184	0.0184	0.0003	0	0.1754	0.1754	0.0308	0.5	0.5189	0.0189	0.0004
0.5	0.4136	0.0864	0.0075	0.5	0.5058	0.0058	0.0000	0.5	0.4756	0.0244	0.0006
0.5	0.4917	0.0083	0.0001	0.5	0.5052	0.0052	0.0000	0.5	0.4743	0.0257	0.0007
0.5	0.5211	0.0211	0.0004	0.5	0.5361	0.0361	0.0013	0.5	0.3847	0.1153	0.0133
0.5	0.5114	0.0114	0.0001	0.5	0.5248	0.0248	0.0006	0.5	0.4698	0.0302	0.0009

Training				Validation				Testing			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.5	0.4543	0.0457	0.0021	0.5	0.4619	0.0381	0.0015	0.5	0.526	0.026	0.0007
0.5	0.4883	0.0117	0.0001	0.5	0.4637	0.0363	0.0013	0.5	0.5406	0.0406	0.0016
0.5	0.4236	0.0764	0.0058	0.5	0.3165	0.1835	0.0337	0.5	0.0666	0.4334	0.1878
0.5	0.4913	0.0087	0.0001	0	0.4958	0.4958	0.2458	0.5	0.3964	0.1036	0.0107
0.5	0.3162	0.1838	0.0338	0.5	0.6004	0.1004	0.0101	0.5	0.5736	0.0736	0.0054
0.5	0.4819	0.0181	0.0003	0.5	0.5215	0.0215	0.0005			Sum of Error	4.4231
0.5	0.5184	0.0184	0.0003	0.5	0.6086	0.1086	0.0118			MSE	0.0417
0.5	0.567	0.067	0.0045	0.5	0.5057	0.0057	0.0000				
0.5	0.468	0.032	0.0010	0.5	0.4955	0.0045	0.0000				
0.5	0.5212	0.0212	0.0004	0.5	0.4566	0.0434	0.0019				
0.5	0.4323	0.0677	0.0046	0.5	0.5406	0.0406	0.0016				
0.5	0.4401	0.0599	0.0036	0.5	0.4958	0.0042	0.0000				
0.6	0.5235	0.0765	0.0059	0.5	0.6524	0.1524	0.0232				
0.7	0.6994	0.0006	0.0000	0.5	0.4873	0.0127	0.0002				
0.5	0.4821	0.0179	0.0003	0	0.6102	0.6102	0.3723				
0.5	0.4775	0.0225	0.0005	0	0.3296	0.3296	0.1086				
0.5	0.516	0.016	0.0003	0	0.3981	0.3981	0.1585				
0.5	0.4698	0.0302	0.0009	0	0.5707	0.5707	0.3257				
0.5	0.475	0.025	0.0006	0	0.5023	0.5023	0.2523				
0.5	0.523	0.023	0.0005	0.5	0.4664	0.0336	0.0011				
0.5	0.4916	0.0084	0.0001	0.5	0.0276	0.4724	0.2232				
0.5	0.4671	0.0329	0.0011	0.5	0.5893	0.0893	0.0080				
0.5	0.5116	0.0116	0.0001	0.5	0.5084	0.0084	0.0001				
0.5	0.5446	0.0446	0.0020	0.5	0.5028	0.0028	0.0000				
0.5	0.5396	0.0396	0.0016	0.5	0.4854	0.0146	0.0002				
0.5	0.447	0.053	0.0028	0.5	0.4848	0.0152	0.0002				
0.5	0.5336	0.0336	0.0011	0.5	0.5317	0.0317	0.0010				
0.5	0.5328	0.0328	0.0011	0.5	0.5065	0.0065	0.0000				
0.5	0.5042	0.0042	0.0000	0.5	0.5862	0.0862	0.0074				
0.5	0.4898	0.0102	0.0001	0.5	0.5199	0.0199	0.0004				
0.5	0.4949	0.0051	0.0000	0	0.1608	0.1608	0.0259				
0.5	0.4965	0.0035	0.0000	0.8	0.49	0.31	0.0961				
0.5	0.4692	0.0308	0.0009	0	0.2493	0.2493	0.0622				
0.5	0.4842	0.0158	0.0002	0	0.5536	0.5536	0.3065				
0.5	0.44	0.06	0.0036	0.5	0.4868	0.0132	0.0002				

Training				Validation			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.5	0.5187	0.0187	0.0003	0.5	0.4685	0.0315	0.0010
0.5	0.4607	0.0393	0.0015	0.5	0.4814	0.0186	0.0003
0.5	0.3808	0.1192	0.0142	0.5	0.4733	0.0267	0.0007
0.5	0.5679	0.0679	0.0046	0.5	0.4793	0.0207	0.0004
0.5	0.4538	0.0462	0.0021	0.5	0.3865	0.1135	0.0129
0.5	0.4967	0.0033	0.0000	0.5	0.5083	0.0083	0.0001
0.5	0.477	0.023	0.0005	0.5	0.5461	0.0461	0.0021
0.5	0.4946	0.0054	0.0000	0.5	0.5411	0.0411	0.0017
0.5	0.4993	0.0007	0.0000	0.5	0.5225	0.0225	0.0005
0.5	0.4618	0.0382	0.0015	0.5	0.527	0.027	0.0007
0.5	0.3472	0.1528	0.0233	0.5	0.5153	0.0153	0.0002
0.5	0.399	0.101	0.0102	0.5	0.5054	0.0054	0.0000
0.5	0.4811	0.0189	0.0004	0	0.1702	0.1702	0.0290
0.5	0.4865	0.0135	0.0002	0	0.2679	0.2679	0.0718
0.5	0.4664	0.0336	0.0011	0.5	0.4847	0.0153	0.0002
0.5	0.4989	0.0011	0.0000	0.6	0.481	0.119	0.0142
0.5	0.4831	0.0169	0.0003	0.5	0.5404	0.0404	0.0016
0.5	0.4792	0.0208	0.0004	0.5	0.5362	0.0362	0.0013
0.5	0.5012	0.0012	0.0000	0.5	0.4849	0.0151	0.0002
0	0.1684	0.1684	0.0284	0.5	0.5151	0.0151	0.0002
0.5	0.5172	0.0172	0.0003	0.5	0.4675	0.0325	0.0011
0.5	0.4615	0.0385	0.0015	0.4	0.5337	0.1337	0.0179
0.5	0.4996	0.0004	0.0000	0.5	0.4956	0.0044	0.0000
0.5	0.5157	0.0157	0.0002	0.5	0.374	0.126	0.0159
0.5	0.5062	0.0062	0.0000	0	0.4646	0.4646	0.2159
0.5	0.5396	0.0396	0.0016	0.5	0.8725	0.3725	0.1388
0.5	0.4997	0.0003	0.0000	0.5	0.4766	0.0234	0.0005
0.5	0.5552	0.0552	0.0030	0.5	0.5426	0.0426	0.0018
0.5	0.4771	0.0229	0.0005	0.5	0.5281	0.0281	0.0008
0.5	0.4794	0.0206	0.0004	0.5	0.5321	0.0321	0.0010
0.5	0.4985	0.0015	0.0000	0.5	0.4962	0.0038	0.0000
0.5	0.5206	0.0206	0.0004	0.5	0.5108	0.0108	0.0001
0.5	0.5083	0.0083	0.0001	0.5	0.0646	0.4354	0.1896
0.5	0.4912	0.0088	0.0001	0.5	0.5477	0.0477	0.0023

Training				Validation			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.5	0.4856	0.0144	0.0002	0	0.4918	0.4918	0.2419
0.5	0.4858	0.0142	0.0002	0.5	0.5321	0.0321	0.0010
0.5	0.5455	0.0455	0.0021	0.5	0.5293	0.0293	0.0009
0.5	0.5127	0.0127	0.0002	0.5	0.501	0.001	0.0000
0.5	0.5323	0.0323	0.0010	0.5	0.3661	0.1339	0.0179
0.5	0.4837	0.0163	0.0003	0.5	0.5906	0.0906	0.0082
0.5	0.5262	0.0262	0.0007	0	0.5465	0.5465	0.2987
0.5	0.5066	0.0066	0.0000	0	0.4969	0.4969	0.2469
0	0.3356	0.3356	0.1126	0	0.4799	0.4799	0.2303
0.5	0.5146	0.0146	0.0002	0.5	0.4968	0.0032	0.0000
0.5	0.4733	0.0267	0.0007	0.5	0.5241	0.0241	0.0006
0.5	0.5062	0.0062	0.0000	0.5	0.4746	0.0254	0.0006
0.5	0.4588	0.0412	0.0017	0.5	0.4272	0.0728	0.0053
0.5	0.467	0.033	0.0011	0.5	0.4749	0.0251	0.0006
0	0.1778	0.1778	0.0316	0.5	0.5407	0.0407	0.0017
0.5	0.3065	0.1935	0.0374	0.5	0.4364	0.0636	0.0040
0.5	0.4917	0.0083	0.0001	0.5	0.4476	0.0524	0.0027
0.5	0.472	0.028	0.0008	0.5	0.4802	0.0198	0.0004
0.5	0.5514	0.0514	0.0026	0.5	0.4946	0.0054	0.0000
0.5	0.4665	0.0335	0.0011	0.5	0.4944	0.0056	0.0000
0.5	0.5144	0.0144	0.0002	0.5	0.4086	0.0914	0.0084
0.5	0.5197	0.0197	0.0004	0	0.1649	0.1649	0.0272
0.5	0.5582	0.0582	0.0034	0	0.4838	0.4838	0.2341
0	0.3767	0.3767	0.1419	0.5	0.5176	0.0176	0.0003
0.5	0.5058	0.0058	0.0000	0.5	0.4929	0.0071	0.0001
0.5	0.4645	0.0355	0.0013	0.5	0.4952	0.0048	0.0000
0.5	0.5085	0.0085	0.0001	0.5	0.512	0.012	0.0001
0.5	0.4451	0.0549	0.0030	0.5	0.4183	0.0817	0.0067
0.5	0.5219	0.0219	0.0005	0.5	0.4179	0.0821	0.0067
0.5	0.5147	0.0147	0.0002	0.5	0.3245	0.1755	0.0308
0.5	0.5028	0.0028	0.0000	0.5	0.9163	0.4163	0.1733

Training				Validation			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.5	0.4644	0.0356	0.0013	0	0.5119	0.5119	0.2620
0.5	0.3909	0.1091	0.0119	0	0.5046	0.5046	0.2546
0.5	0.4889	0.0111	0.0001	0.5	0.4069	0.0931	0.0087
0.5	0.4676	0.0324	0.0010	0	0.373	0.373	0.1391
0.5	0.4117	0.0883	0.0078	0	0.3196	0.3196	0.1021
0.5	0.4956	0.0044	0.0000	0	0.5081	0.5081	0.2582
0.5	0.4597	0.0403	0.0016	0	0.4212	0.4212	0.1774
0.5	0.5257	0.0257	0.0007	0	0.1404	0.1404	0.0197
0.7	0.3673	0.3327	0.1107	0	0.4007	0.4007	0.1606
0.5	0.4784	0.0216	0.0005	0	0.4986	0.4986	0.2486
0.5	0.5062	0.0062	0.0000	0	0.4363	0.4363	0.1904
0.5	0.5017	0.0017	0.0000	0	0.5569	0.5569	0.3101
0.5	0.4799	0.0201	0.0004	0.5	0.4732	0.0268	0.0007
0.5	0.383	0.117	0.0137	0.5	0.5405	0.0405	0.0016
0.5	0.467	0.033	0.0011	0.5	0.4734	0.0266	0.0007
0.5	0.4834	0.0166	0.0003	0.5	0.5952	0.0952	0.0091
0.5	0.42	0.08	0.0064	0.5	0.519	0.019	0.0004
0.5	0.5018	0.0018	0.0000	0.5	0.0117	0.4883	0.2384
0.5	0.4074	0.0926	0.0086	0.5	0.5062	0.0062	0.0000
0.5	0.4823	0.0177	0.0003	0.5	0.344	0.156	0.0243
0.5	0.4882	0.0118	0.0001	0.5	0.4636	0.0364	0.0013
0.5	0.3806	0.1194	0.0143	0.5	0.4601	0.0399	0.0016
0.5	0.493	0.007	0.0000	0.5	0.5291	0.0291	0.0008
0.5	0.5016	0.0016	0.0000	0.5	0.3654	0.1346	0.0181
0.5	0.412	0.088	0.0077	0.5	0.511	0.011	0.0001
0.5	0.5421	0.0421	0.0018	0.5	0.4615	0.0385	0.0015
0.5	0.4266	0.0734	0.0054	0.5	0.496	0.004	0.0000
0.5	0.4967	0.0033	0.0000	0.5	0.547	0.047	0.0022
0	0.116	0.116	0.0135	0	0.49	0.49	0.2401
0.5	0.4857	0.0143	0.0002	0	0.3708	0.3708	0.1375
0.5	0.4246	0.0754	0.0057	0.5	0.3865	0.1135	0.0129

Training				Validation			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.5	0.4925	0.0075	0.0001	0	0.5122	0.5122	0.2623
0	0.1484	0.1484	0.0220	0.5	0.4554	0.0446	0.0020
0	0.2409	0.2409	0.0580	0.5	0.4467	0.0533	0.0028
0.5	0.5152	0.0152	0.0002	0.5	0.4113	0.0887	0.0079
0	0.3952	0.3952	0.1562	0.5	0.5236	0.0236	0.0006
0.5	0.5118	0.0118	0.0001	0.5	0.4443	0.0557	0.0031
0.5	0.5151	0.0151	0.0002	0.5	0.4546	0.0454	0.0021
0.5	0.5004	0.0004	0.0000	0.5	0.4765	0.0235	0.0006
0.5	0.4969	0.0031	0.0000	0.5	0.5176	0.0176	0.0003
0.5	0.5774	0.0774	0.0060	0.5	0.363	0.137	0.0188
0.5	0.5454	0.0454	0.0021	0.5	0.4976	0.0024	0.0000
0.5	0.5129	0.0129	0.0002	0.5	0.5627	0.0627	0.0039
0.5	0.5023	0.0023	0.0000	0.6	0.8036	0.2036	0.0415
0.5	0.4618	0.0382	0.0015	0.7	0.3873	0.3127	0.0978
0.5	0.4586	0.0414	0.0017	0.5	0.4804	0.0196	0.0004
0	0.0078	0.0078	0.0001	0.5	0.4208	0.0792	0.0063
0.5	0.4951	0.0049	0.0000	0.5	0.36	0.14	0.0196
0.5	0.4874	0.0126	0.0002	0.5	0.4591	0.0409	0.0017
0.5	0.5217	0.0217	0.0005	0.5	0.5401	0.0401	0.0016
0.5	0.4716	0.0284	0.0008	0.5	0.6043	0.1043	0.0109
0.5	0.4801	0.0199	0.0004	0.5	0.0955	0.4045	0.1636
0.5	0.4776	0.0224	0.0005	0.5	0.5017	0.0017	0.0000
0.5	0.5209	0.0209	0.0004	0.5	0.5169	0.0169	0.0003
0.5	0.4247	0.0753	0.0057	0.5	0.5116	0.0116	0.0001
0.5	0.5231	0.0231	0.0005	0.5	0.4835	0.0165	0.0003
0.5	0.4543	0.0457	0.0021	0.5	0.5127	0.0127	0.0002
0.5	0.4958	0.0042	0.0000	0.5	0.5471	0.0471	0.0022
0.5	0.4979	0.0021	0.0000	0.5	0.3617	0.1383	0.0191
0.5	0.5137	0.0137	0.0002	0.5	0.2464	0.2536	0.0643
0.5	0.535	0.035	0.0012	0.5	0.4946	0.0054	0.0000
0.5	0.4983	0.0017	0.0000	0.5	0.4544	0.0456	0.0021

Training				Validation			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0	0.2407	0.2407	0.0579	0.5	0.4633	0.0367	0.0013
0	0.2454	0.2454	0.0602	0.5	0.4318	0.0682	0.0047
0	0.221	0.221	0.0488	0.5	0.4997	0.0003	0.0000
0.5	0.5057	0.0057	0.0000	0.5	0.9436	0.4436	0.1968
0	0.0899	0.0899	0.0081	0	0.4096	0.4096	0.1678
0	0.048	0.048	0.0023	0.5	0.4507	0.0493	0.0024
0	0.2062	0.2062	0.0425	0.5	0.1631	0.3369	0.1135
0.5	0.5124	0.0124	0.0002	0.5	0.4076	0.0924	0.0085
0.5	0.2253	0.2747	0.0755	0.5	0.521	0.021	0.0004
0.5	0.5394	0.0394	0.0016	0.5	0.4818	0.0182	0.0003
0.5	0.4818	0.0182	0.0003	0.5	0.5287	0.0287	0.0008
0.5	0.4871	0.0129	0.0002	0.5	0.4036	0.0964	0.0093
0.5	0.4082	0.0918	0.0084	0.5	0.378	0.122	0.0149
0.5	0.5255	0.0255	0.0007	0.5	0.4953	0.0047	0.0000
0.5	0.4763	0.0237	0.0006	0.5	0.1728	0.3272	0.1071
0.5	0.4919	0.0081	0.0001	0.5	0.1986	0.3014	0.0908
0.5	0.5469	0.0469	0.0022	0.5	0.4822	0.0178	0.0003
0.5	0.5292	0.0292	0.0009	0.5	0.4302	0.0698	0.0049
0.5	0.5013	0.0013	0.0000	0.5	0.5407	0.0407	0.0017
0.5	0.4279	0.0721	0.0052	0.5	0.398	0.102	0.0104
0.8	0.8126	0.0126	0.0002	0.5	0.5476	0.0476	0.0023
0.5	0.4554	0.0446	0.0020	0.5	0.4403	0.0597	0.0036
0.5	0.4837	0.0163	0.0003	0.5	0.4005	0.0995	0.0099
0.5	0.4597	0.0403	0.0016	0.5	0.411	0.089	0.0079
0.5	0.4628	0.0372	0.0014	0.5	0.5229	0.0229	0.0005
0.5	0.5365	0.0365	0.0013	0.5	0.2808	0.2192	0.0480
0.5	0.51	0.01	0.0001	0.5	0.4707	0.0293	0.0009
0.5	0.5351	0.0351	0.0012	0.5	0.3562	0.1438	0.0207
0.5	0.5066	0.0066	0.0000	0.5	0.538	0.038	0.0014
0.5	0.4666	0.0334	0.0011	0.5	0.0515	0.4485	0.2012
0.5	0.5049	0.0049	0.0000	0.5	0.4942	0.0058	0.0000

Training				Validation			
Actual	Predicted	Error	Square of Error	Actual	Predicted	Error	Square of Error
0.5	0.3487	0.1513	0.0229	0.5	0.2428	0.2572	0.0662
0.5	0.4427	0.0573	0.0033	0	0.5555	0.5555	0.3086
0.5	0.5088	0.0088	0.0001	0.5	0.3173	0.1827	0.0334
0.5	0.4884	0.0116	0.0001	0.5	0.1509	0.3491	0.1219
0.5	0.4571	0.0429	0.0018	0.5	0.6048	0.1048	0.0110
0.5	0.5165	0.0165	0.0003	0.5	0.528	0.028	0.0008
0.5	0.499	0.001	0.0000	0.5	0.523	0.023	0.0005
0.5	0.3797	0.1203	0.0145	0.5	0.2006	0.2994	0.0896
0.5	0.5034	0.0034	0.0000	0.5	0.5391	0.0391	0.0015
0.5	0.4389	0.0611	0.0037	0.5	0.4127	0.0873	0.0076
0.5	0.4541	0.0459	0.0021	0.5	0.5228	0.0228	0.0005
0.5	0.523	0.023	0.0005	0.5	0.5409	0.0409	0.0017
0.5	0.4762	0.0238	0.0006	0.5	0.3687	0.1313	0.0172
0.5	0.2696	0.2304	0.0531	0.5	0.4404	0.0596	0.0036
0.5	0.3847	0.1153	0.0133	0.5	0.6272	0.1272	0.0162
0.5	0.4568	0.0432	0.0019	0	0.313	0.313	0.0980
0.5	0.4955	0.0045	0.0000	0.5	0.3355	0.1645	0.0271
0.5	0.4879	0.0121	0.0001	0.5	0.5126	0.0126	0.0002
0.5	0.4901	0.0099	0.0001	0.5	0.4326	0.0674	0.0045
0.5	0.413	0.087	0.0076	0.5	0.8466	0.3466	0.1201
0.5	0.5023	0.0023	0.0000	0.5	0.4109	0.0891	0.0079
0.5	0.5596	0.0596	0.0036	0	0.5012	0.5012	0.2512
0.7	0.7031	0.0031	0.0000	0.5	0.4584	0.0416	0.0017
0.5	0.4495	0.0505	0.0026	0.5	0.3942	0.1058	0.0112
0.5	0.4832	0.0168	0.0003	0.5	0.52	0.02	0.0004
0	0.1775	0.1775	0.0315	0.4	0.5102	0.1102	0.0121
0	0.2429	0.2429	0.0590	0.5	0.3309	0.1691	0.0286
0	0.1949	0.1949	0.0380	0.5	0.5058	0.0058	0.0000
0.5	0.5021	0.0021	0.0000	0.5	0.4817	0.0183	0.0003
0	0.396	0.396	0.1568	0.5	0.5654	0.0654	0.0043
0.5	0.5162	0.0162	0.0003	0.5	0.1245	0.3755	0.1410

Training				Validation			
Actual	**Predicted**	**Error**	**Square of Error**	**Actual**	**Predicted**	**Error**	**Square of Error**
0.5	0.5524	0.0524	0.0027	0.5	0.4721	0.0279	0.0008
0.5	0.485	0.015	0.0002	0.5	0.4276	0.0724	0.0052
0.5	0.5351	0.0351	0.0012	0.4	0.5407	0.1407	0.0198
0.5	0.5148	0.0148	0.0002	0.5	0.3558	0.1442	0.0208
0.5	0.4869	0.0131	0.0002	0.5	0.2672	0.2328	0.0542
0.5	0.4022	0.0978	0.0096	0.5	0.5755	0.0755	0.0057
0.5	0.5059	0.0059	0.0000	0.5	0.5325	0.0325	0.0011
0.5	0.4873	0.0127	0.0002	0.5	0.5149	0.0149	0.0002
		Sum of Error	2.7526			**Sum of Error**	16.9627
		MSE	0.0083			**MSE**	0.0509

APPENDIX G

GANTT CHART OF COMPLETION

Suggested Milestone for the First Semester of Final Year Project

No.	*Detail/ Week*	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	***Selection of Project Topic***	■	■												
		✓	✓												
2.	***Preliminary Research Work***			■	■	■	■	■	■						
	- Project planning of completion			✓	✓	✓	✓								
3.	***Submission of Preliminary Report***				●										
					✓										
4.	***Project Work***					■	■	■	■						
	- Analysis on various tuning methods					✓	✓	✓							
5.	***Submission of Progress Report***								●						
									✓						
6.	***Software Progress***								■	■	■	■	■		
	- Develop the algorithm for the program									✓	✓	✓	✓		
7.	***Submission of Interim Report***													●	
														✓	
8.	***Oral Presentation***														●
															✓

●	*Milestone*
■	*Process*
✓	*Actual*

Suggested Milestone for the Second Semester of Final Year Project

No.	*Detail/ Week*	1	2	3	4	5	6	7	8	9	10	11	15	19	22
1	***Matlab Training Network***	■	■	■	■	■	■	■	■						
	- Final Phase of Completion		✓	✓	✓	✓	✓	✓	✓						
2	***Submission of Progress Report 1***				●										
					✓										
3.	***GUI of the program –***				■	■	■	■	■	■					
	- Link the programs together						✓	✓	✓						
5.	***Submission of Progress Report 2***								●						
									✓						
6.	***Submission of Dissertation Draft***												●		
													✓		
7.	***Oral Presentation***													●	
														✓	
8.	***Submission of Project Dissertation***														●
															✓

●	*Milestone*
■	*Process*
✓	*Actual*